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Checkout and Launch Control System (CLCS) System Level Specification

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Checkout and Launch Control System (CLCS)

System Level Specification

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1. INTRODUCTION

1.1 SCOPE

This document identifies the system level requirements that are the basis for the development of the Checkout and Launch Control System (CLCS). It contains requirements for the Real-Time Processing System (RTPS), Shuttle Data Center (SDC), Simulation System (SIM), and the Business and Information Network (BIN).

1.2 SYSTEM OVERVIEW

The CLCS is composed of the RTPS, the SDC, the SIM, and the BIN. The RTPS provides the capability to monitor and control the elements of the current Space Shuttle Flight Vehicle and Ground Support Equipment (GSE). The SDC is the repository for the Shuttle Launch Processing Test Data and provides the capability to build Test Packages for configuration of the RTPS. The capability to debug and certify RTPS software and to aid in the training of checkout and launch personnel is provided by the SIM. The BIN provides RTPS workstation connectivity and access to non-RTPS applications and data. CLCS provides support to the Space Shuttle Program into the 21st Century and a basic infrastructure upon which to base future design projects such as the Orbiter Upgrades and X-33/RLV.

The CLCS replaces the current Launch Processing System (LPS) with state-of-the-art Commercial Off the Shelf (COTS) based technology. Where task requirements can be met safely by COTS software products, the COTS software is utilized instead of developing custom applications. Any custom software that is developed is written in high level languages which have demonstrated a high degree of portability between platforms. COTS hardware is also utilized where possible in the CLCS. This strategy provides a reliable system that is modular, expandable, and extensible. It is based on open hardware and software standards, easily incorporates new technology and user developed applications, and provides inherent user interface improvements.

1.3 RELATED DOCUMENTS

CP09IT0916	Launch Processing System Checkout, Control and Monitor Subsystem Hardware Interface Module Assembly	December 1975
ICD-2-0A003	Flight Vehicle/LPS Computational Systems Interfaces, Rev. J	November 1994
ICD-2-19001	Shuttle Orbiter/Cargo Standard Interfaces, Rev. K	October 1995
IRIG-200-95	Inter-Range Timing Format	July 1995
KSC-GP-792	Timing Signal Formats	February 1972
KSCL-1143-0463	SCAN Design Specifications	February 1997
SS-P-0002-140T	Space Shuttle Computer Program Development Specifications (CPDS) SS Downlist/Uplink Software Requirements	October 1995
SS-P-0002-150N	Space Shuttle Computer Program Development Specifications SSL LDB Software Interface Requirements Data Bank Services Requirements Specification	March 1996
83K001102	HIM-II Detailed Design Document	September 1994

1.4 DOCUMENT OVERVIEW

This document is identified as the CLCS System Level Specification (SLS). The document is organized into three main sections. Section 1 contains the introduction to the CLCS and the SLS and includes a list of documents referenced within the SLS. The actual CLCS system requirements can be found in Section 2 of the SLS, which is further divided into five subsections. The first subsection contains requirements for the CLCS in general. Subsections two through five are each dedicated to a CLCS Major Subsystem (RTPS, SDC, BIN, SIM). Finally, the third section of the SLS is dedicated to Blue Book Requirements that have not been incorporated within Section 2 and the reasoning for the omission.

1.5 DOCUMENT CONVENTIONS

The term "shall" is used in this document to indicate that the sentence in which it is used is a requirement levied on one or more products in the CLCS. Conventional MIL-STD terminology is used for products; definitions of

many of which can be found in the glossary. Each section of the document normally begins with a description of the items that are discussed within the section. In many cases, the term “must” is used in the description paragraphs to indicate functions that are needed in the CLCS and should not be construed as requirements on the CLCS. A “Rationale” section is optionally provided for further explanation regarding one or more requirements. These rationale paragraphs also do not impose requirements on the CLCS.

In requirements statements, the term CLCS is used when the requirement may be satisfied by Configuration Items (CIs) in one or more of the CLCS Major Subsystems. When a specific CLCS Major Subsystem (RTPS, SDC, BIN, SIM) is named, the requirement is allocated only to CIs in that specific Subsystem.

2. CLCS SYSTEMS REQUIREMENTS

This section contains the systems requirements for the CLCS. It is organized into five subsections. The first subsection contains the requirements that apply to more than one of the major CLCS subsystems. The remaining four subsections contain the requirements specific to each of the major CLCS subsystems:

1. Real-Time Processing System Requirements
2. Business and Information Network Requirements
3. Shuttle Data Center Requirements
4. Simulation Requirements

2.1 CLCS SYSTEMS REQUIREMENTS

This section contains the CLCS Systems Requirements that are applicable to more than one of the major subsystems within the CLCS.

2.1.1 EXTERNAL SYSTEMS INTERFACE REQUIREMENTS

The RTPS must provide various external systems interfaces. Some of these interfaces, namely ones to the Flight Vehicle, are the same as those used by the CCMS. Refer to Table 2.1 for a summary of the external systems. The table lists the interface name, a generic type of signal expected, the expected data rates, which element of CLCS the interface is with, and where the interface point is within CLCS

INTERFACE	TYPE	RATE	CLCS	INTERFACE POINT
Launch Data Bus	Serial	1 Mbs	RTPS	FOTE (Gateway Interface Adapter)
Orbiter OFI PCM Downlink	PCM	64 Kbs, 96 Kbs, 128 Kbs, 192 Kbs	RTPS	FOTE (Gateway Interface Adapter)
Main Engine PCM Downlink	PCM	60 Kbs	RTPS	FOTE (Gateway Interface Adapter)
PCM Uplink	PCM	32 Kbs, 72 Kbs, 128 Kbs	RTPS	FOTE (Gateway Interface Adapter)
Ground Data Bus	Serial	1 Mbs	RTPS	FOTE (Gateway Interface Adapter)
Complex Control Set	Serial	TBD	RTPS	TBD
Facility Timing UTC	IRIG	low-rate serial	RTPS	Facility Timing System
Facility Timing CDT/MET	MILA	low-rate serial	RTPS	Facility Timing System
Time Management Distribution System (TMDS)	Discrete	N/A	RTPS	
Hardwire Safing System	Discrete and Analog	N/A	RTPS	LCC Hardwire Safing Patch Panel
Ground Measurement System (GMS)	Ethernet UDP/IP	4 packets/sec	RTPS	Gateway Interface Adapter
Pad Meteorological System (Metro)	Serial RS-422	1 packet/sec	RTPS	Gateway Interface Adapter
Lightning and Transients Monitoring System (LATMOS)	Serial RS-422	TBD	RTPS	Gateway Interface Adapter
Hydrogen Umbilical Mass Spectrometer (HUMS)	Ethernet TCP/IP	TBD	RTPS	Gateway Interface Adapter

INTERFACE	TYPE	RATE	CLCS	INTERFACE POINT
Portable Aft Mass Spectrometer (PAMS)	Ethernet TCP/IP	TBD	RTPS	Gateway Interface Adapter
Backup Hazardous Gas Detection System (B/U HGDS)	RS-422 Serial	TBD	RTPS	Gateway Interface Adapter
Remote Monitoring Systems	TBD	TBD	TBD	TBD
Orbiter Upgrades	TBD	TBD	TBD	TBD
Space Station / TCMS	TBD	TBD	TBD	TBD
Reconfiguration Network (RNET)	Ethernet TCP/IP	TBD	SDC	Network Firewall/Router
Engineering Data Access Management Systems (EDAMS)	Ethernet TCP/IP	N/A	SDC	Network Gateway/Router
Shuttle Connector Analysis Network (SCAN)	Ethernet TCP/IP	TBD	SDC	Network Gateway/Router
Shuttle Processing Data Management System (SPDMS)	Ethernet	TBD	SDC	Network Gateway/Router
Kennedy Switched Data Network (KSDN)	None	N/A	None	None
Launch Operations Network (LON)	Ethernet TCP/IP	N/A	SDC	Network Gateway/Router
LPS Software Development Network (LSDN)	Ethernet TCP/IP	N/A	SDC	Network Gateway/Router
Shuttle Operations Data Network (SODN)	Ethernet TCP/IP	N/A	SDC	Network Gateway/Router
CLCS Data Exchange	Ethernet TCP/IP	TBD	SDC	Network Gateway/Router
Marshall Space Flight Center (MSFC)	PSCNI	2,000 Kbs	SDC	Network Gateway/Router
Johnson Space Center (JSC)	PSCNI	750 Kbs	SDC	Network Gateway/Router
Stennis Space Center (SSC)	PSCNI	Ethernet	SDC	Network Gateway/Router
Dryden Flight Research Center (DFRC)	PSCNI	750 Kbs	SDC	Network Gateway/Router
Payload Operations Control Centers (POCC)	PSCNI	128 Kbs	CITE RTPS	Gateway Interface Adapter

Table 2.1 - External Systems Interfaces

2.1.1.1 Launch Data Bus (LDB) Interface

The Launch Data Bus (LDB) is the interface between the Orbiter data processing system and all applicable ground facilities for test, checkout, maintenance, preflight, and post-flight phases. In addition, this common software interface provides the RTPS with access to the devices that are attached to the LDB when the General Purpose Computers (GPC) are not active on the LDB.

The LDB is a burst-mode asynchronous bi-phase Manchester II encoded 1 Mbs data bus using 28 bit words. There are two identical, independent Launch Data Buses. The two LDBs may be used as a redundant pair, or may be used independently, as needed.

Although part of the LDB is a true bi-directional, half-duplex, redundant data bus, most of the ground portion of the bus consists of two sets of unidirectional data lines; two Uplink buses and two downlink buses. The LDBs are simplex data buses between the RTPS gateway and the Orbiter LPS Signal Adapter (OLSA), and full duplex serial buses between the OLSA and the Orbiter. At the interface to the RTPS Gateway, the electrical signal is a differential 1 VP-P +/- 0.2 VP-P at 124 Ohms balanced.

2.1.1.1.1 The RTPS shall meet the requirements allocated to the LPS/LDB interface specified in:

1. SS-P-0002-150, Space Shuttle LDB Software Interface Requirements
2. ICD-2-0A003, Section 3, Flight Vehicle/LPS Computational Systems Interface

2.1.1.1.2 The RTPS shall provide the capability, in GPC Mode, to issue commands and to receive measurement data, via the GPCs, from:

1. Orbiter Multiplexers/Demultiplexers (MDM) (i.e., Flight Critical, Payload, Flex, SCA, and Command Decoders)
2. Master Events Controller (MEC)
3. Pulse Coded Modulation Master Units (PCMMU)
4. Mass Memory Units (MMU)
5. SSME Controllers
6. Solid Rocket Booster (SRB) MDMs
7. Engine Interface Units (EIU)
8. Payload Data Interleaver (PDI)
9. Payload Signal Processor (PSP)
10. Space Lab (SL) Experiment/Subsystem Computers

2.1.1.1.3 The RTPS shall provide the capability, in Direct Input/Output (DIO) Mode (i.e., when the GPCs are not active), to issue commands to and receive measurements from:

1. Solid Rocket Booster MDMs
2. Command Decoder MDMs

2.1.1.1.4 The RTPS shall provide the capability to interface with all GPC Functional Destinations available via the LDB, including:

1. Systems Software Avionics Command Support (SACS)
2. Test Control Supervisor Single Commands (TCS-1)
3. Mass Memory (MM)/Display Electronics Unit (DEU) Read
4. Space Shuttle Main Engine (SSME) Load Program (SLP)
5. Launch Sequence (LS)
6. Test Control Supervisor Test Sequences (TCS-S)

2.1.1.1.5 The RTPS shall provide the capability to load, modify, dump, and verify the Orbiter Computational Facilities (OCF) according to the following matrix:

Function	GPC Main Memory	TCS Registers	Mass Memory	DEU Memory	SSME
Load		X	X	X	X
Dump	X	X	X	X	X
Verify	X		X	X	X

Function	GPC Main Memory	TCS Registers	Mass Memory	DEU Memory	SSME
Modify	X		X	X	X

2.1.1.1.6 The RTPS shall provide the capability to synchronize Greenwich Mean Time (GMT) on board the Orbiter's Master Timing Unit (MTU) to Universal Time Coordinated (UTC) with an accuracy of less than or equal to 1/8th of a millisecond (0.125 msec).

2.1.1.2 Orbiter OFI PCM Downlink Interface

The Operational Flight Instrumentation (OFI) Pulse Code Modulation (PCM) downlink interface consists of a one-way telemetry data stream from the Orbiter PCM Master Unit (PCCMU). This downlink is the primary method for the Orbiter to communicate measurements, health, and status to the ground system.

The Orbiter OFI PCMMU transmits Operational Instrumentation (OI) data, GPC data, and Payload (PLD) data in a Bi-Phase-L time division multiplexed data stream at 64 Kbs, 96 Kbs, 128 Kbs, and 192 Kbs. The 96 Kbs and 192 Kbs data streams contain 32 Kbs and 64 Kbs of voice data respectively. The voice data is not directly processed by RTPS. The downlink may consist of several variable length and content formats. The signal is a unidirectional continuous data stream using bi-phase Manchester II encoding. At the CLCS Gateway, the electrical signal is differential 1 VP-P +/- 0.2 VP-P at 124 Ohms balanced.

2.1.1.2.1 The RTPS shall provide the capability to receive, decommutate, and process PCM downlink information from the PCMMU as described in:

1. ICD-2-0A003, Flight Vehicle/LPS Computational Systems Interface
2. ICD-2-19001, Shuttle Orbiter/Cargo Standard Interfaces
3. SS-P-0002-140, Space Shuttle Downlist/Uplink Software Requirements

2.1.1.2.2 In addition, the RTPS shall provide the capability to receive, decommutate, and process payload PCM downlink information as described in:

1. ICD-2-0A003, Section 12, Flight Vehicle/LPS Computational Systems Interface

2.1.1.3 Main Engine PCM Downlink Interface

The Space Shuttle Main Engine (SSME) Pulse Code Modulation (PCM) downlink interface consists of three separate one-way telemetry data streams from the Orbiter Main Engine Controllers (MEC) via the Engine Interface Units (EIU). This downlink is the primary method for the SSMEs to communicate measurements, health, and status to the ground system.

The three Main Engine Controllers each transmit a 60 Kbs NRZ-L data stream via the launch umbilicals while the Flight Vehicle is on the pad, and all three data streams are multiplexed into the S-band Frequency Modulated (FM) signal during ascent. Unlike the multi-format OFI downlink, the SSME downlink consists of a single fixed format. The signal is a unidirectional continuous data stream using bi-phase Manchester II encoding. At the RTPS Gateway, the electrical signal is differential 1 VP-P +/- 0.2 VP-P at 124 Ohms balanced.

2.1.1.3.1 The RTPS shall provide the capability to receive and process PCM downlink information from the three Space Shuttle Main Engine Controllers as defined in:

1. ICD-2-0A003, Section 5, Flight Vehicle/LPS Computational Systems Interface.

2.1.1.4 PCM Uplink Interface

The Pulse Code Modulation (PCM) Uplink interface provides the capability to transmit commands to the Orbiter and payloads via the Orbiter General Purpose Computers (GPC).

The PCM Uplink is a time division multiplexed data stream that operates in one of two modes: the operational mode or the forward link mode. In the operational mode, the Uplink is transmitted at a rate of 32 Kbs or 72 Kbs from the ground to the Network Signal Processor (NSP) on-board the Orbiter. In the forward link mode data is transmitted at 128 Kbs to the Communications Interface Equipment (CIE) on-board the Orbiter via the Communications and Tracking (C&T) station.

The command Uplink consists of a 6.4 Kbs command channel, 1.2 Kbs of sync, and 0.4 Kbs of Station Identifier (ID). The remainder of the bandwidth is dedicated to voice. The RTPS does not supply the voice data, but instead provides an alternating 1-0 bit fill pattern. The signal is a unidirectional continuous data stream using bi-phase Manchester II encoding. At the CLCS Gateway, the electrical signal is differential 1 VP-P +/- 0.2 VP-P at 124 Ohms balanced.

2.1.1.4.1 The RTPS shall provide the capability to Uplink commands to the Orbiter GPC via the PCM Uplink interface as defined in:

1. SS-P-0002-140, Space Shuttle Downlist/Uplink Software Requirements.

2.1.1.4.2 At CITE, the RTPS shall provide the capability to generate Uplink commands in the "NSP Switched Out" format.

2.1.1.4.3 At CITE, the RTPS shall provide the capability to generate Uplink commands in the "NSP Switched In" format

2.1.1.4.4 At CITE, the RTPS shall provide the capability for the Uplink interface to operate in the "Forward link Mode"

2.1.1.5 Ground Data Bus Interface

The Ground Data Bus (GDB) communicates with Hardware Interface Modules (HIM) located at various locations around the LC-39 area to monitor and control Ground Support Equipment (GSE) and facilities. There are two types of HIMs, the original CCMS HIMs, plus new HIM-IIs scheduled for installation in FY97/98. The HIM-IIs implement a 44-bit protocol in addition to the original HIM 28-bit protocol to allow higher resolution analog input cards to be used. The protocol is selectable at the HIM, but only a single protocol may be active on any given GDB at a time.

The Ground Data Bus is a burst-mode, bi-directional, full-duplex, asynchronous 1 Mbs Manchester II data bus. The HIM uses a 28-bit packet (GSE Type-I) with 100 usec spacing between packets, while the HIM-II is also capable of utilizing a 44-bit packet structure (GSE Type-II). At the interface to the RTPS Gateway, the electrical signal is a differential 1 VP-P +/- 0.2 VP-P at 124 Ohms balanced.

2.1.1.5.1 The RTPS ground data bus shall interface with both the CCMS Hardware Interface Module (HIM), and the replacement HIM-II.

2.1.1.5.2 The RTPS shall interface using the GSE Type-I Data Bus (28-bit) with the HIM/HIM-II via the protocol described in:

1. CP90IT0916 CCMS HIM End Item Specification

2.1.1.5.3 The RTPS shall interface using the GSE Type-II Data Bus (44-bit) with the HIM-II via the protocol described in:

1. 83K001102 HIM-II Design Document

2.1.1.5.4 The CLCS shall support a minimum of two (2) GSE Data Buses per RTPS Gateway.

Rationale: The existing system supports two data buses per FEP, and the current cable plant and GSE redundancy (i.e., how end items are connected to HIMs) is based on this number.

2.1.1.5.5 The RTPS shall support a minimum of eight (8) HIM/HIM-IIs per data bus.

Rationale: The CCMS system supports eight HIMs per data bus, and the current cable plant and GSE redundancy (i.e., how end items are connected to HIMs) is based on this number.

2.1.1.5.6 The RTPS shall support any possible mixture of HIMs and HIM-IIs on the same data bus using the GSE Type-I Data Bus protocol. Only HIM-IIs shall be supported using the Type-II Data Bus.

Rationale: It is unlikely that HIM-IIs will be installed collectively, and therefore a mixture of HIMs and HIM-IIs may exist during the installation period.

2.1.1.5.7 The RTPS shall receive and process all HIM-II health and status commands as specified in:

1. 83K001102 HIM-II Design Document

2.1.1.5.8 The RTPS shall be capable of polling HIM/HIM-IIs 19.9 miles from the RTPS gateway.

2.1.1.6 Complex Control Set Interfaces

The Complex Control Set currently interfaces to both Remote Terminal Units (RTU) and Programmable Logic Controllers (PLC) located around the LC-39 and Industrial Areas, in addition to standard Ground Data Bus interfaces. It is uncertain which of these interfaces will be required by CLCS, and this is the subject of on-going evaluations.

2.1.1.6.1 The CCS RTPS shall interface to Remote Terminal Units (RTU)s as described in:

1. TBD

2.1.1.6.2 The CCS RTPS shall interface to Programmable Logic Controllers as described in:

1. TBD

2.1.1.7 Facility Timing UTC Interface

The Coordinated Universal Time (UTC) interface receives UTC from the facility Timing Terminal Unit in IRIG-B123 format and processes the input data stream for distribution within CLCS.

2.1.1.7.1 The CLCS shall be capable of accepting and processing a continuous IRIG-B123 signal as defined in:

1. KSC-GP-792, Section 2.8, Timing Signal Formats
2. IRIG-200-95, sections applicable to IRIG-B123, Inter-Range Timing Formats

2.1.1.8 Facility Timing CDT/MET Interface

Countdown Time (CDT) and Mission Elapsed Time (MET) are generated by the RTPS and used by various components of CLCS and external users as a reference for the current location within the countdown or mission. CDT becomes MET when time passes from minus time to positive time.

2.1.1.8.1 The RTPS shall be capable of outputting CDT/MET at a 1 second rate to the facility timing interface in the MILA format described in:

1. (TBD)

2.1.1.8.2 The RTPS shall provide the capability to set, start, stop, hold, and resume CDT/MET.

2.1.1.9 Time Management Distribution System Interface

The Time Management Distribution System (TMDS) allows the RTPS to drive various hold-time-remaining clocks. This is accomplished by a set of discrete outputs (i.e., a HIM chassis and card) located in the CDBFR timing rack today.

2.1.1.9.1 The RTPS shall provide the capability to start/stop/set/reset the “time remaining” clocks in the OCR/MFR.

2.1.1.9.2 The RTPS shall provide the capability of accepting a “hold” command from external sources (Test Director/Test Conductor).

2.1.1.10 Hardwire Safing System Interface

The Hardwire Safing System provides an alternate means of controlling and monitoring critical GSE in the event of a failure of the RTPS. This consists of mostly hardwired 28V lines that perform two functions: cut-off the power to selected HIMs, thereby returning their outputs to a zero (de-energized) state; and provide direct control and monitor of selected GSE components. Separately, a Flight Vehicle safing capability is provided as detailed in Section 2.2.6, Safing and Biomed.

2.1.1.10.1 The RTPS shall be capable of accepting 28V discrete and analog signals from the existing Hardwire Safing System.

2.1.1.10.2 The RTPS shall be capable of outputting 28V discrete and analog signals to the existing Hardwire Safing System.

2.1.1.10.3 The RTPS shall interface to the existing Hardwire Safing System at the Hardwire Safing Patch Panel using existing Pad, OPF, and VAB wiring, sensors and effectors.

2.1.1.11 Ground Measurement System (GMS) Interface

The Permanent Measurements System (PMS) is an early 1980's PC-based data system using LabViews to monitor approximately 800 channels of environmental and special measurements during Shuttle launches. The PMS is being replaced with a system called the Advanced Data Acquisition System (ADAS). Each transducer, when calibrated, will be mated to a cable pig-tail containing a programmable memory device, called tag-ram, that will contain all of the calibration and other relevant data in a remotely accessible format. When the transducer is installed in the field a Universal Signal Conditioning Amplifier (USCA) will be attached to the pig-tail which will automatically read the tag-ram and configure itself in a default configuration according to the tag-ram data. This includes excitation voltage, filtering, and up to eighth order linearization performed in real-time. Software called ADAS Command Application (ACA) allows an operator to reconfigure the USCA from a keyboard located in the LCC instead of making hardware changes. The data streams are merged onto a fiber optic data link and transmitted to the LCC where telemetry equipment records it and provides a quick look data output. The USCA and AUI upgrades are to be complete by the end of FY01. The new system is known as the Ground Measurement System (GMS).

2.1.1.11.1 The Ground Measurement System (GMS) interface shall be via an Ethernet network using UDP/IP.

2.1.1.12 Pad Meteorological System (Metro) Interface

The Pad Meteorological System (Metro) consists of two weather instrumentation towers at each LC-39 pad connected to a real-time processor in the LCC. Data is acquired at higher resolution (12-bit) than the original CCMS provided.

2.1.1.12.1 The Pad Meteorological System (Metro) interface shall be via a buffered RS-232 interface as described in:

1. KSC-DL-3768, LC-39 Pad Meteorological System LCC Computer System Theory of Operations

2.1.1.13 Lightning and Transients Monitoring System (LATMOS) Interface

The Catenary Wire Lightning Instrumentation System (CWLIS) senses any lightning currents in the wire and evaluates them to see what potential they may have for causing damage to sensitive electrical equipment. The CWLIS current sensors are located at each end of the Catenary Wire and detect and record lightning flashes to provide potential damage assessment data for the CWLIS system.

The Lightning Induced Voltage Instrumentation System (LIVIS), detects and records any transient electrical charges that might exist in Space Shuttle electronic systems or on the vehicle's skin. This system is installed in the MLP and monitors conditions while the Shuttle is on the way to the launch pad via the crawlerway and at the pad itself. Two additional LIVIS sensors monitor the induced effects of any lightning activity in the Payload Changeout Room inside the Rotating Service Structure.

Data recorded by both the CWLIS and LIVIS systems are compiled and sent to the Launch Control Center through the computers of the Lightning and Transients Monitoring System (LATMOS).

2.1.1.13.1 The CLCS interface to the Lightning and Transients Monitoring System (LATMOS) shall be via a buffered RS-422 interface.

2.1.1.14 Hydrogen Umbilical Mass Spectrometer (HUMS)

The HUMS is a mass spectrometer equipped with a turbo-molecular vacuum pump to allow the analysis of gases primarily composed of helium. It provides back-up for the combustible gas sensor leak monitors and can be switched to monitor any sample line from the Prime and Back-up Hazardous Gas Detection System (HGDS).

2.1.1.14.1 The CLCS interface to the Hydrogen Umbilical Mass Spectrometer (HUMS) shall be via an Ethernet network via TCP/IP using X-Windows/Motif compliant clients.

2.1.1.15 Portable Aft Mass Spectrometer (PAMS) Interface

The Portable Aft Mass Spectrometer (PAMS) is a cart-mounted rebuilt commercial leak detector with new electronics, inlet leak system, and vacuum pumps. The PAMS will detect helium levels of 0.1 ppm in a nitrogen or air background. The cart is controlled via a laptop computer with graphical user interface and is extremely easy for non-experts to operate and understand. They are also being used for leak testing the Shuttle main engines, prior to installation in the Orbiter (each flow), and are slated to be used for leak testing the Orbital Maneuvering Systems.

2.1.1.15.1 The CLCS interface to the Portable Aft Mass Spectrometer (PAMS) shall be via an Ethernet network using TCP/IP.

2.1.1.16 Backup HGDS Interface

A Backup Hazardous Gas Detection System (HGDS) was added as part of the Return To Flight using different mass spectrometer technologies than the Primary HGDS.

2.1.1.16.1 The CLCS interface to the Backup Hazardous Gas Detection System (HGDS) shall be via a buffered RS-422 interface.

2.1.1.17 Remote Monitoring Systems Interface

Various systems both on and off the Kennedy Space Center require data currently provided by the Shuttle Data Stream. Systems at KSC include advisory (expert) systems such as the Knowledge-based Autonomous Test Engineer (KATE) and the Vehicle Health Management System (VHMS), as well as office (desk-top) computers in engineering facilities. Off-KSC systems are located at MSFC, JSC, DFRC, and contractor facilities in Downey, California.

2.1.1.17.1 The CLCS shall provide a monitor-only data stream to external users as described in:

1. (TBD)

2.1.1.18 Orbiter Upgrades Interface

The Orbiter Upgrades Project is currently being defined and will result in new or modified interfaces for CLCS. None of these interfaces are sufficiently mature to include in this release of this document.

1. (TBD)

2.1.1.19 Space Station/TCMS

The International Space Station Program, and its Test, Control and Monitor System (TCMS), will result in new or modified interfaces for CLCS. None of these interfaces are sufficiently mature to include in this release of this document.

1. (TBD)

2.1.1.20 Reconfiguration Network (RNET) Interface

The Reconfiguration Network (RNET) allows the transfer of vehicle Measurement-Stimulus Identifier (MSID) data from the JSC Software Production Facility (SPF) to CLCS. JSC has implemented special security considerations that force SDC to use compatible firewall software at KSC in order to interface with the SPF. This interface has functionally replaced the Shuttle Data Tape originally used in CCMS.

2.1.1.20.1 The SDC shall provide the capability to interface with the JSC Software Production Facility (SPF) to transfer RNET products between JSC and KSC.

2.1.1.20.2 The SDC RNET interface shall conform to JSC security requirements applicable to the RNET interface.

2.1.1.21 Engineering Data Access Management System (EDAMS) Interface

The Engineering Data Access Management System (EDAMS) allows networked workstations to access the following GSDE functions:

- EDAMS Vehicle/Payload/GSS Systems Drawing Access
- EDAMS Facility Condition Assessment Program (FCAP)

- EDAMS Automated Material Request System (AMRS)
- EDAMS Automated WAD Processing System (AWPS)
- EDAMS Utility Outage Processing System (UOPS)
- EDAMS Automated Logging System (ALS)

2.1.1.21.1 The CLCS interface to the Engineering Data Access Management System (EDAMS) shall be via an Ethernet network via TCP/IP using X-Windows/Motif compliant clients.

2.1.1.22 Shuttle Connector Analysis Network (SCAN) Interface

Shuttle Connector Analysis Network (SCAN) is built around a distributed network of commercial-off-the-shelf UNIX workstations connected, via a client/server methodology, to the SCAN database. The SCAN database consists of one relational database instance which is broken down into one tablespace per Orbiter, one for each non-Orbiter element (payload, SSME, and OMS), and one general purpose tablespace for global information. Each Orbiter tablespace manages the “as-built” wiring configuration of that Orbiter, plus the mate/demate/retest status of all onboard connectors and functions, and the analysis of impacts to in-progress and/or planned testing. Each non-Orbiter tablespace manages the “as-built” wiring configuration of that element for all four Orbiters.

2.1.1.22.1 The CLCS interface to the Shuttle Connector Analysis Network (SCAN) shall be via an Ethernet network using TCP/IP as described in:

1. KSCL-1143-0463 SCAN Design Specifications

2.1.1.23 Shuttle Processing Data Management System (SPDMS) Interface

The Shuttle Processing Data Management System (SPDMS) consists of an integrated set of application software, computer hardware, operating systems, database managers, and communications network hardware and software. It is the primary Enterprise system for KSC vehicle processing.

2.1.1.23.1 The Shuttle Processing Data Management System, (SPDMS) interface shall be via an Ethernet network.

2.1.1.24 Kennedy Switched Data Network (KSDN) Interface

The Kennedy Switched Data Network is being phased out of service in FY97/98, and CLCS should not need to interface to it.

2.1.1.25 Launch Operations Network (LON) Network Interface

The Launch Operations Network (LON) is a logical collection of networks around the LC-39 area used to support Space Shuttle operations.

2.1.1.25.1 The Launch Operations Network (LON) interface shall be via an Ethernet network using TCP/IP.

2.1.1.26 LPS Software Development Network (LSDN) Network Interface

The LPS Software Development Network (LSDN) is an existing network of HP workstations located throughout the LC-39 area to support Space Shuttle operations. The LSDN is used primarily for the development of applications software, sustaining engineering of LPS hardware and software, and documentation and configuration management.

2.1.1.26.1 The CLCS interface to the LPS Software Development Network (LSDN) shall be via an Ethernet network using TCP/IP.

2.1.1.27 Shuttle Operations Data Network (SODN) Interface

This is the CLCS interface to the “real” Internet, with appropriate firewalls and gateways to ensure security and data integrity.

2.1.1.27.1 The CLCS interface to the Shuttle Operational Data Network (SODN) shall be via an Ethernet network using TCP/IP.

2.1.1.28 CLCS Data Exchange Interface

The CLCS requires internal connectivity between its various elements (RTPS, SDC, and SIM) for software loading, retrievals, recording, etc. For the equipment located within the Launch Control Center (LCC) these

interfaces are internal within CLCS and are not covered here. However, for CLCS equipment sets located remotely from the LCC (i.e., CITE, HMF, and SAIL) these interfaces will be transmitted across NASA-owned or common carrier communications and therefore constitute "external" interfaces.

2.1.1.28.1 The CLCS shall provide interfaces to load software, provide simulations, record data, and retrieve data between the SDC and the RTPS located in the CITE.

2.1.1.28.2 The CLCS shall provide interfaces to load software, provide simulations, record data, and retrieve data between the SDC and the RTPS located in the HMF.

2.1.1.28.3 The CLCS shall provide interfaces to load software, provide simulations, record data, and retrieve data between the SDC and the RTPS located in the SAIL.

2.1.1.29 Marshall Space Flight Center (MSFC) Interface

The Marshall Space Flight Center (MSFC) includes a number of organizations (including the HOSC, Pratt & Whitney, and others) that receive the KSC-generated Shuttle Data Stream (SDS) using COTS Ethernet hardware by way of 2,000 Kbs of allocated PSCNI bandwidth using a point-to-point server. Various other clients (POCCs, etc.) are supported by redistribution from MSFC. Space Shuttle Main Engine raw PCM telemetry data is also sent to MSFC for decommutation in the HOSC.

2.1.1.29.1 The CLCS shall make SDS-equivalent data available to the Marshall Space Flight Center (MSFC) per existing inter-Center agreements.

2.1.1.29.2 The CLCS shall provide the three raw SSME PCM data streams to Marshall Space Flight Center.

2.1.1.30 Johnson Space Center (JSC) Interface

The Mission Operations Integration Room (MOIR)/Mission Evaluation Room (MER) provides facilities to monitor shuttle testing and launch operations. The Mission Evaluation Room (MER) at JSC provides facilities to monitor Space Shuttle processing and launch operations. MER receives the KSC-generated Shuttle Data Stream (SDS) using COTS ethernet hardware by way of a 750 Kbs dedicated point-to-point LON gateway link. In addition, the RNET interface is provided to download mission files to KSC using standards based communications over PSCNI.

2.1.1.30.1 The CLCS shall make SDS-equivalent data available to the Johnson Space Center (JSC) per existing inter-Center agreements.

2.1.1.31 Stennis Space Center (SSC) Interface

The Stennis Space Center (SSC) receives the KSC-generated Shuttle Data Stream (SDS) using COTS Ethernet hardware by way of PSCNI using a point-to-point server. In Addition, select engine test stand data from Stennis is sent to KSC using ethernet over PSCNI.

2.1.1.31.1 The CLCS shall make SDS-equivalent data available to the Stennis Space Center (SSC) per existing inter-Center agreements.

2.1.1.31.2 The CLCS shall receive selected SSME test stand data from the Stennis Space Center via an ethernet network over PSCNI.

2.1.1.32 Dryden Flight Research Center (DFRC) Interface

The Dryden Flight Research Center (DFRC) receives the Shuttle Data Stream (SDS) using COTS Ethernet hardware by way of a 750 Kbs dedicated point-to-point LON gateway link. Backup is provide by two 19.2 baud dedicated PSCNI circuits and a 2400 baud dial up line.

2.1.1.32.1 The CLCS shall make SDS-equivalent data available to the Dryden Flight Research Center (DFRC) per existing inter-Center agreements.

2.1.1.33 Payload Operations Control Centers (POCC) Interface

SpaceLab science missions are controlled from the Payload Operations Control Center (POCC) in Huntsville, Alabama. The POCC is capable of receiving the Shuttle Data Stream from the MSFC interface. In addition, the POCC can receive data and issue commands to payloads under test at CITE.

2.1.1.33.1 The CITE RTPS shall provide an interface to the Payload Operations Control Center functionally equivalent to the CITE-POCC Interface in CCMS

2.2 REAL-TIME PROCESSING SYSTEM REQUIREMENTS

The RTPS is the portion of the CLCS that provides real-time process control for the Space Shuttle Flight Vehicle and supporting Ground Support Equipment during pre-launch processing, checkout, and launch. This system is similar to the Checkout, Control, and Monitor System (CCMS) in the LPS. The RTPS is essentially a command and control system that provides manual and automated processes for controlling end item hardware and software found in environments such as the processing facilities at the Kennedy Space Center (KSC). Although the RTPS is similar in many regards to the CCMS it differs in a number of significant ways:

1. The RTPS utilizes COTS technology and open architecture standards when task requirements can be met by this strategy. In the CCMS, proprietary technologies, restricted memories and the low processing power available in computers in the mid-70s forced a design that was tailor made to the processors in the system. This tailoring made it extremely difficult and costly to upgrade processors and the software residing in them. The COTS standards allow the capability to upgrade processors or software in a much more cost effective manner.
2. The RTPS is a message based system rather than a storage based system. In the CCMS, current values of measurements were stored in the Common Data Buffer (CDBFR). These values were updated only when the measurement value changed by a significant amount. Messages were sent to registered applications only when an exception violation occurred. In the RTPS, all measurement changes are distributed throughout the entire system.
3. The RTPS operates on higher levels of data than the CCMS. In the CCMS, only measurement and command data were available to all users. In the RTPS, higher levels of data are constructed and managed within the system in a manner similar to the way in which measurement and command data were handled in the CCMS.
4. RTPS mechanisms provide users and applications more details regarding the health of the measurement data available to them. For example, when a measurement link is down, the situation is reported to the users and applications whenever requests for the measurement data are received or whenever the data health changes rather than requiring each application to analyze the system and determine if the data is valid.
5. The newer hardware technologies of today, incorporated within the RTPS, bring inherently greater Mean Time Between Failure (MTBF) times and lower Mean Time to Repair (MTTR) times, thus lowering maintenance costs and increasing system availability.
6. Due to the significant advances in graphics technologies, the RTPS has cost effective displays which are richer in content and meaning and easier to understand and use.

The RTPS must provide similar capabilities and functionality of the CCMS.

2.2.1 CRITICAL FUNCTIONS REQUIREMENTS

This section contains the RTPS Critical Function Requirements. These requirements serve as the drivers for the design of the RTPS.

2.2.1.1 System

2.2.1.1.1 The RTPS shall be fault tolerant. Specifically, the system shall provide the capability to recover from subsystem failures in the following areas:

1. Command and Control Processing
2. Data Distribution Processing
3. Critical Data Acquisition Gateways (i.e., LDB, 128 & 192 Kb PCM, GSE)
4. Real Time Critical Network and the Display and Control Network

Rationale: The RTPS must provide safe processing and control capability for the Flight Vehicle and related GSE. Consideration should also be given to cost and expandability. Redundancy will be provided as necessary, the level of which will correlate with the criticality and practicality of the situation. For example, the Console Position equipment is not required to be redundant because launch control engineering personnel can move to a spare Console Position and continue working in the event of a Console Position equipment failure. Beyond the

Console Position equipment, higher levels of redundancy and fault tolerance are needed than provided by LPS in order to ensure safety and reduce processing time and cost.

2.2.1.1.2 The CLCS shall be designed to have a high level of data integrity. Specifically the system shall provide the following:

1. No loss of command data within the CLCS
2. No loss of measurement data within the CLCS
3. No loss of measurement samples to applications requesting such service
4. No data which has been corrupted within the CLCS
5. Health data on a measurement basis

Rationale: The RTPS is a process control system for the Flight Vehicle and related GSE. It must provide safe, redundant, and reliable control for elements of ground and flight systems. Most of the decisions made by the users and applications are based on the data acquired by the system. In order for the decisions to be accurate they must be based on valid data. Although the RTPS cannot regulate the accuracy of data prior to its arrival in the RTPS, the CLCS must neither lose nor corrupt data once it has entered the system. Additionally, the users and applications must be notified whenever data acquired by the system is known to be stale (e.g., not currently being acquired because it isn't in the current telemetry format).

2.2.1.1.3 The RTPS shall provide fault tolerance in the Command and Control HCI positions.

Rationale: The same level of fault tolerance is not provided in the Command and Control HCI positions as in other areas of the RTPS design. These positions will be connected to the DCN such that a DCN failure will still allow approximately half of the workstations to remain operational. A workstation or network adapter failure will require another workstation to be used.

2.2.1.1.4 The loss of any RTPS Real Time Network component shall not cause switchover of more than one standby subsystem.

2.2.1.1.5 All RTPS subsystem computers shall be equipped with error detection and correction logic.

2.2.2 PERFORMANCE REQUIREMENTS

The Real-Time Processing System (RTPS) portion of the Checkout and Launch Control System (CLCS) must provide timely responses to both End-Item events and Human inputs to provide safe processing of launch vehicles. This section captures the critical performance requirements which affect multiple hardware and software components of the RTPS.

2.2.2.1 System

2.2.2.1.1 The "system maximum data bandwidth" shall support 25,000 end item changes per second continuously.

2.2.2.1.2 The system shall support 50,000 end item measurement changes in a given second without losing any data.

Rationale: The system will need to have a flow control mechanism to support buffering instead of losing data when peak change rates occur. This system is being used to consolidate several systems. Some of these systems and their rates are TBD. Therefore the above requirements are written with expansion in mind. We do not want to say the system will support all changes on all links.

2.2.2.1.3 The system shall support 1,000 end item measurement changes during a 10 millisecond period.

2.2.2.1.4 The system shall provide the capability to issue a commands a single test (control) application to support every LDB command opportunity (120 milliseconds).

Rationale: The CLCS needs to provide the capability for an application to issue LDB commands without waiting on the response so that every available command opportunity can be used.

2.2.2.1.5 The system shall execute a GSE reactive sequence, which simply tests 10 FDs, changes the constraints on 10 FDs and responds to the notification with a command, in less than 100 milliseconds from the time the measurement (1000 samples per second) changes at the HIM input until the command is issued at the HIM output while the system is at the “system maximum data bandwidth” and the subsystem executing the sequence has 20 test applications executing.

2.2.2.1.6 The system shall execute a GSE control loop, which simply responds to the notification with a command, in less than 100 milliseconds from the time the measurement (1000 samples per second) changes at the HIM input until the command is issued at the HIM output while the system has a minimal data load and the subsystem executing the control loop has no other applications executing.

2.2.2.1.7 A command to change the constraints for up to 500 measurements shall take less than 250 milliseconds.

2.2.2.1.8 GSE command/response latency of a priority command, or of a non-priority command in an unloaded system, shall be less than 20 milliseconds from the time a test/control application issues the command until the response is received by the application.

2.2.2.1.9 GSE command/response latency of a non-priority command in a loaded system with 20 applications executing in the same subsystem shall be less than 100 milliseconds from the time the test/control application issues the command until the response is received by the application.

Rationale: The command/response latency includes the time from the application executing the command all the way out to the HIM and back to that application. This requirement is trying to capture the fact that the response to a command must be received before executing the next ‘instruction’ and that this is critical to the timely execution of test/control applications.

2.2.2.1.10 One user’s test applications shall be able to read 10,000 measurements, and “verify” them in a single second in an unloaded system.

2.2.2.1.11 The time from a measurement change being detected by the system until that measurement is available for retrieval shall be less than five seconds.

2.2.2.1.12 A near-real-time single measurement retrieval request shall begin to return data to the requester in less than five seconds.

2.2.2.1.13 The system shall support executing a manual command in less than one second from human execution to HIM output.

2.2.2.1.14 The Data Health Function shall support the “system maximum data bandwidth”.

2.2.2.1.15 The Data Fusion function shall support the “system maximum data bandwidth” with one fusion calculation per change.

2.2.2.1.16 The Constraint Function’s data limit function shall support three constraint checks per measurement FD while supporting the “system maximum data bandwidth”, including Fusion FDs.

2.2.2.1.17 The Constraint Manager notification function shall be capable of providing 100 notifications per second while supporting the “system maximum data bandwidth”.

2.2.2.1.18 The data distribution function shall support the “system maximum data bandwidth”, plus 5,000 (20%) Data Fusion updates per second.

2.2.2.1.19 The system shall meet all GLS timing requirements specified in KLO-82-0071.

2.2.2.1.20 The system shall support (while executing at 40 percent of the system maximum data bandwidth) 25 Constraint Management requests from each of 4 Command and Control Processor Subsystems (100 Total), 20 constraint event notifications (5 per CCP), and 4 commands (1 per CCP) with each CCP executing 20 User Test Applications which are executing 500 Application Service calls per second (TBD).

2.2.2.2 Subsystem

2.2.2.2.1 All gateways shall be able to support full link bandwidth with all values changing every sample.

2.2.2.2.2 RTPS shall be able to support full Uplink command rates on the following links:

- LDB - 8/second
- PCM Uplink - 16.67/second or 50/second
- GSE - 500/second.

2.2.2.2.3 All gateways shall be able to support table maintenance changes under a full data rate load.

2.2.2.2.4 All subsystems acquiring data from external GSE shall be synchronized to Range Time to within 10 microseconds to support 100 microsecond measurement time-stamping.

2.2.2.2.5 All subsystems (except workstations and GSE Link Gateways) shall be synchronized to Range Time within TBD microseconds to support 1 millisecond time-stamping of measurements.

2.2.2.2.6 The Display function shall, for a single workstation, support updating of 250 displayed FDs out of 500 in one second.

2.2.2.2.7 The Display function shall, for a single workstation, support updating 50% of the FD's every second on 13 windows with 100 FD's in each window.

2.2.2.2.8 The Display function shall support, for a single workstation, up to 4000 FDs on screens that are active but not displayed.

2.2.2.2.9 The system shall, for a single workstation, display a new graphical screen with up to 500 FDs in one second when the screen (active but not displayed) is selected for viewing.

2.2.2.2.10 Screen capture (for screen printing, etc.) shall take less than 0.5 seconds from initiation until the user can control/change the display.

2.2.2.2.11 Screen print shall take less than ten seconds to a local dedicated printer.

2.2.2.2.12 Changing from one display to another shall take less than 250 milliseconds.

2.2.2.2.13 Each CCP shall support 5 End-Item System test applications, with 6 applications for each System (30 Processes) with each application executing 500 Application Service calls per second (15,000 calls/second) while executing at 5 percent of the system maximum data bandwidth (TBD). The ratio of application service calls are 45 local application services (read, if, compare, etc.), 4 constraint management notification changes and 1 command for every 50 calls. The applications are to be the same priority level and each is allowed to execute at least 10 times per second.

2.2.2.3 Redundancy

2.2.2.3.1 GSE and PCM Gateways, configured as a redundant pair, shall switch to the standby Gateway with no loss of measurement data and within 1 System Synchronous Rate Time Period of detection.

2.2.2.3.2 For Gateways (except LDB) configured as a redundant pair, switch-over for commands shall be completed in less than 20 milliseconds without any loss of commands.

2.2.2.3.3 LDB Gateway switch-over shall be accomplished without any loss of data or commands and shall be completed in less than 500 milliseconds.

2.2.2.4 Non-Realtime

2.2.2.4.1 The wall clock time to complete a launch configuration Test Build shall not exceed 30 minutes.

2.2.2.4.2 The System Software (including COTS tools and Operating System) reload for a single subsystem shall take less than 30 minutes.

2.2.2.4.3 The time required to load a launch configuration Test Set shall not exceed 2 hours.

2.2.2.4.4 A loaded and initialized Launch Configuration Test Set shall take less than 5 minutes to be activated.

2.2.2.4.5 The time required to reconfigure a Test Set to a new Test shall not exceed 15 minutes, assuming the new Test was previously loaded..

2.2.2.4.6 The time required to reconfigure a failed Subsystem to an operational state, assuming all software is already loaded on local disk, shall not exceed 15 minutes.

2.2.3 MEASUREMENT AND COMMAND PROCESSING REQUIREMENTS

One of the aspects that makes the CLCS RTPS unique is its ability to process a wide variety of measurement data in various ways along with an integrated command and control capability. This section provides requirements relating to measurement and command processing in the RTPS.

2.2.3.1 Acquisition and Distribution of Data

Data is acquired in the RTPS by Gateways attached to a variety of external systems.

2.2.3.1.1 The RTPS shall provide the capability to acquire data from the sources identified in the External Systems Interface Requirements Section 2.1.1 of this document.

2.2.3.1.2 The RTPS shall check each measurement acquired for change and if a change is detected shall convert the data to the RTPS internal format and distribute the data to users.

2.2.3.1.3 The RTPS shall maintain the current value of all Measurement FD for access by application SW.

2.2.3.1.4 The RTPS shall provide the capability for applications to request all changes of Measurement FDs and have them provided along with time of change and health at the time of change.

2.2.3.1.5 The RTPS shall provide changed measurement data to system and user applications at the System Synchronous Rate.

2.2.3.1.6 The RTPS shall provide changed measurement data to display applications at the Display Synchronous Rate.

2.2.3.1.7 The RTPS shall provide the capability to update measurement and command data when needed.

2.2.3.2 Data Types and Formats

The CLCS must process all data types that exist on the GSE, Orbiter, and Payloads and that are processed by CCMS. In addition, the CLCS must process some data types which are not processed by CCMS, but which are required by the CLCS itself or systems that the CLCS will interface with in the future. Formats of measurement data in CLCS are important because of the ramifications various formats options have on:

1. Bandwidth of networks.
2. Processor computing power requirements.
3. Labor required to develop software in the various options.
4. Labor required to sustain data in the various options.

2.2.3.2.1 The CLCS shall process all data types processed by the CCMS except MODCOMP Floating Point Data Types. (See Appendix B)

2.2.3.2.2 The CLCS shall process the following additional data types.

Measurement Types	Command Types
12 bit GSE Analogs	12 bit GSE Analogs

Measurement Types	Command Types
16 bit GSE Analogs	16 bit GSE Analogs
Multi-word digital patterns	Multi-word digital patterns
Strings	Strings
IEEE 754 floating point	IEEE 754 floating point
State (Enumerated)	State (Enumerated)

Rationale: Some of the data types in the table above may be processed on some of the CCMS links. The CLCS requirement is to expand the links that can support these data types on the needed CLCS links.

2.2.3.2.3 The CLCS shall provide the capability to use calibrated engineering units in all system and application programs where program decisions are made or where the data is displayed, printed, or stored.

2.2.3.2.4 The CLCS shall provide the capability to use converted count data in all system and application programs where program decisions are made, or where the data is displayed, printed, or stored.

2.2.3.2.5 The CLCS shall provide the capability to update calibration values for measurements in the RTPS without loading new test control information or interrupting non affected applications.

2.2.3.3 Command Processing

The CLCS must provide the capability to issue commands available with the LPS. In addition, the CLCS must issue new command types which will be required by systems that the CLCS will interface with in the future.

2.2.3.3.1 The CLCS shall provide the capability to issue all keyboard commands in Appendix C with a Y in the column titled “implement”.

2.2.3.3.2 The CLCS shall provide the capability to protect from inadvertent issuance of commands.

1. Prerequisite logic
2. Two step protocol required on critical commands entered from the keyboard (e.g., arm, execute, and disarm logic)

2.2.3.3.3 The CLCS shall provide the capability to restrict issuance of commands to only authorized users and applications.

2.2.4 MISCELLANEOUS SYSTEM SERVICES AND SYSTEM APPLICATIONS REQUIREMENTS

This section contains requirements relating to System Services and System Application programs. These programs are developed to collect in one place functions which are needed by many system and user applications programs.

2.2.4.1 Manual Command, Monitoring and Control

The CLCS provides a means of manually commanding, monitoring, and controlling end item hardware and software similar to the Command Processor in the CCMS. The Command Processor functions will be analyzed on a one for one basis and each function will be allocated to the appropriate area within the CLCS for development.

2.2.4.1.1 The CLCS shall provide, using a Graphical User Interface (GUI) paradigm, the capabilities identified in Appendix C with a Y in the column titled Implement.

2.2.4.2 System Messages

The CLCS provides a central repository for messages which are utilized by custom system and application software developed for the RTPS. The repository contains information for each of these messages, known as System Messages, such as message text, source, severity etc. Using a System Message Viewer, users may register for and receive System Messages for a requested Message Group and Severity.

2.2.4.2.1 The CLCS shall provide a central repository for System Messages and their associated definitions.

2.2.4.2.2 The RTPS shall allow users to register for and receive recent and new System Messages for a requested Message Group and Severity.

2.2.4.2.3 Every System Message shall provide sufficient information regarding why the System Message is being generated.

2.2.4.2.4 The RTPS shall provide the capability to associate additional data with any System Message (e.g., Help and status information of a set of resources).

2.2.4.2.5 Each System Message shall have a unique identifier.

2.2.4.2.6 The System Message Viewer shall provide an audible warning capability.

2.2.4.3 System Viewers

CLCS will provide a set of System displays which provide information to the user without the user creating a display application. These system viewers will provide information about Measurement FDs. There are other displays provided with CLCS which are discussed in the sections with the associated functionality.

2.2.4.3.1 The RTPS shall provide a set of System Viewers which provide selected data for display without requiring the user to develop a specific display.

2.2.4.3.2 The RTPS shall provide a FD Viewer which provides a mechanism for viewing all available information about a measurement FD.

2.2.4.3.3 The FD Viewer shall be linkable to user and system displays.

2.2.4.3.4 The FD Viewer shall provide a mechanism for viewing all available information about any measurement FD's Health.

2.2.4.3.5 The FD Viewer shall provide a mechanism for viewing all available information about a Fused FD.

2.2.4.3.6 The FD Viewer shall provide a mechanism for viewing information about constraints asserted against a specific measurement FD.

2.2.4.3.7 The FD Viewer shall update the information displayed only when selected by the user.

2.2.4.3.8 The RTPS shall provide a Constraint Monitor Viewer which provides a mechanism for asserting and viewing constraints against measurement FDs for Constraint Monitor purposes only.

2.2.4.3.9 The RTPS shall provide a Display Monitor Viewer which provides a mechanism for asserting and viewing information for selected measurement FDs for Display Monitor purposes only.

2.2.4.3.10 The Display Monitor Viewer shall periodically update the displayed Measurement FD information.

2.2.4.3.11 The RTPS shall provide the capability for user test applications to setup the Constraint Monitor and Display Monitor Viewers' FDs.

2.2.4.4 Miscellaneous System Services

This section captures requirements for System Services that are not covered elsewhere in the document.

2.2.4.4.1 The RTPS shall provide the capability to capture still images from the HCI screen (on request) and view, print, transfer to another computer, record, or save for later use.

2.2.4.4.2 The RTPS shall provide Timer Services functions for System and User Applications as follows:

1. Delay until a specified time has elapsed
2. Provide time of day and time of year
3. Provide CDT and MET

4. Delay until a specific CDT or MET has arrived

2.2.5 SYSTEM SUPPORT FOR USER APPLICATIONS

CLCS provides several different types of tools for the on-line functionality and off-line editing capabilities required to support user applications for the testing, processing and launching of Flight Vehicles and their payloads. These tools provide the user the capability to command and monitor the End-Item in a safe and efficient manner.

2.2.5.1 General Requirements for User Application Support

The CLCS provides the following application functions to support users: Data Health, Data Fusion, Constraint Management, Prerequisite Control Logic, End-Item Managers, Test Application Scripts, User Displays and User Advisory Expert System Applications.

2.2.5.1.1 The RTPS shall provide fault tolerant End-Item monitoring and control.

2.2.5.1.2 The RTPS shall provide End-Item monitoring and control definition that is directly understandable in form and content by End-Item engineering personnel.

2.2.5.1.3 The RTPS shall provide a layered technique for defining End-Item monitoring and control that supports reuse and reduction of time to implement.

2.2.5.1.4 The RTPS shall provide regression test support for all User Applications.

2.2.5.1.5 The RTPS shall provide the capability to monitor all End-Item FD's current state against expected state during all operational End-Item phases.

2.2.5.1.6 The CLCS shall provide effective support to test director and test management personnel to clearly understand End-Item and test summary status.

2.2.5.1.7 The CLCS shall provide effective support to test director and test management personnel to efficiently and reliably control and track testing progress.

2.2.5.1.8 CLCS shall provide the user the capability to create Pseudo Measurement FDs and generate their values using Test Applications.

2.2.5.1.9 CLCS shall provide the capability for Pseudo Measurement FD values to be persistent between different tests.

2.2.5.1.10 CLCS shall provide the user the capability to choose which Pseudo Measurement FDs are to be persistent.

2.2.5.2 Data Health

To provide a high level of data integrity, the CLCS will provide a Data Health function for Measurement FDs. Each Measurement FD will have a set of Health indicators which can be utilized by both user test applications and displays. These indicators are provided from System Applications, Advisory Systems and Users.

The CLCS provides the capability to inform user and systems or user applications when measurement data is not valid for a variety of reasons. For example, because of bandwidth limitations many measurements that are sent to the ground via PCM are not active during any given mission phase. It is important for users and system or user applications that must make decisions based on the value of a measurement to know that the utilized value is current and, to everyone's knowledge, valid. The system software will determine when measurements are not being updated and will pass this information along to users and system or user applications using the measurement data.

2.2.5.2.1 The RTPS shall automatically track and maintain the health of all Measurement FDs.

2.2.5.2.2 Data health information shall be updated any time the health changes.

2.2.5.2.3 The RTPS shall provide health information to all users and system or user applications of measurement information.

2.2.5.2.4 Users and system and user application shall have the capability to view health and status information on individual and groups of measurements

2.2.5.2.5 The RTPS shall provide the capability to set and reset health and status.

2.2.5.2.6 The RTPS Measurement FD Health function shall be fault tolerant.

2.2.5.2.7 RTPS Measurement FD Health shall include the known information about processing within CLCS including Gateway FD processing and redundancy management

2.2.5.2.8 RTPS Measurement FD Health shall include the capability for manual input by engineering personnel

2.2.5.2.9 CLCS shall provide the capability for users to define Data Path Health algorithms to be utilized by the RTPS Measurement FD Health function.

2.2.5.2.10 RTPS Measurement FD Health shall include the capability to interface with external systems to obtain data that assists in computing Data Path Health.

2.2.5.2.11 RTPS Measurement FD Health shall include the capability for User Advisory Expert System applications to provide Health Warning Indications.

2.2.5.2.12 RTPS Measurement FD Health shall provide a data health layer/encapsulation allowing maintenance in a single place and reuse throughout user applications.

2.2.5.2.13 CLCS shall provide the capability for Measurement Health to be persistent between different tests.

2.2.5.2.14 CLCS shall provide the user with the capability to selectively choose which Measurement FD Health is to be persistent.

2.2.5.3 Data Fusion

Data fusion is the process of combining measurement data and RTPS system parameters into information that may be used in the same manner as measurement data. Fused data may be viewed or used in the same manner as any End-Item Measurement or System Status Function Designator (FD). The process for combining data may include algebraic and logical manipulation of data; conditional testing of system parameters; smoothing or averaging algorithms; or intermediate calculated values. Fused data is a CLCS Measurement FD.

The data fusion capability is provided to reduce the cost of developing application software. Experience with the CCMS LPS has shown that thousands of lines of GOAL code are used in an effort to create data which is essentially measurement data at a higher level than the data that enters the system (e.g., APU Ready for Start, Orbiter Power Is On). This code is repeated in many different CCMS applications throughout the different Engineering Disciplines.

2.2.5.3.1 CLCS shall provide the capability to define, view, and execute the algorithms for performing data fusion.

2.2.5.3.2 A Fused Data Function Designator shall be recalculated whenever any of its input parameters change.

2.2.5.3.3 When the value of a Fused FD changes the new value shall be transmitted to all users, and system or user applications at the System and Display Synchronous Rates.

2.2.5.3.4 The Data Fusion function shall allow activation and deactivation of Fused Data Function Designator Processing.

2.2.5.3.5 The Data Fusion function shall provide the capability to set the value of a Fused FD.

2.2.5.3.6 The RTPS Measurement FD Fusion function shall be fault tolerant.

2.2.5.3.7 The RTPS Measurement FD Fusion function shall provide up to 5 levels of Data Fusion nesting.

2.2.5.3.8 RTPS shall provide the capability to automatically maintain the values of Data Fusion FDs.

2.2.5.3.9 RTPS shall provide a Data Fusion layer/encapsulation allowing maintenance in a single place and reuse throughout user applications.

2.2.5.4 Constraint Management

The RTPS provides the capability to monitor Measurement FDs for a predetermined condition and notify personnel operating the Test Set and software applications executing within the Test Set that the monitored data no longer meets the predetermined condition. This capability is called Constraint Management. Constraint Management is similar to Exception Monitoring in the CCMS; however, it differs in the following manner:

Function or Capability	Exception Monitor (CCMS)	Constraint Manager (RTPS)
Monitoring Accomplished On	End Item Measurement Data Only	All Measurement FDs
Monitoring Accomplished In	FEPs	DDP
Application Notification	1 Set of GOAL Limits	Multiple Applications may set different constraints
Reactive Sequence and Display Notification	Control Logic/EMON Limits Combined	Multiple Limits for Constraint Viewer(s) & Reactive Sequence Applications
Display Capabilities	Dedicated EMON Page	Constraint Viewer(s)
Default Display Limits	N/A	Provided
Summary Constraint Management State	N/A	Provided

2.2.5.4.1 CLCS shall provide the capability to monitor Measurement FDs at the rate the data changes and determine when predefined constraint limits are exceeded or constraint conditions are met.

2.2.5.4.2 CLCS shall provide the capability for multiple (TBD number) users and system or user applications to request notification of constraint events for each Measurement FD.

2.2.5.4.3 CLCS shall provide the capability for each user, and system or user application requesting constraint notification to specify the limits/condition under which they will be notified.

2.2.5.4.4 The CLCS shall provide the capability to monitor measurement data (both converted count data or calibrated engineering units) for out of limits excursions and notify registered users when any of the following conditions occur:

1. N samples in a row that meet the constraint
2. N samples in a given time that meet the constraint
3. There is less than a specified time between constraint events

2.2.5.4.5 CLCS shall provide the capability for any user and system or user application to create new constraints from an application, keyboard, or predefined file, determine and/or view the current constraints and their algorithms, or modify the list of constraints and select the algorithms relating to them.

2.2.5.4.6 The RTPS Constraint Management function shall be fault tolerant.

2.2.5.4.7 RTPS shall provide the capability to test for or view constraint violations at a summary level (e.g., Launch Commit Criteria or OMRSD).

2.2.5.5 Prerequisite Control Logic

To protect against inadvertently issuing a command which could injure personnel or damage equipment, CLCS provides the capability for the user to predefine logic that verifies the appropriate conditions are met prior to executing the command.

2.2.5.5.1 RTPS shall provide the capability to verify that certain conditions are met before issuing any FD command to an End-Item.

2.2.5.5.2 The RTPS Prerequisite Control Logic function shall be fault tolerant.

2.2.5.5.3 RTPS shall provide the capability to manually override Prerequisite Control Logic once command issuance has been blocked.

2.2.5.5.4 RTPS shall provide the capability for Reactive Sequence Test applications to bypass Prerequisite Control Logic.

2.2.5.6 End-Item Management

The End-Item Management function provides the capability for users to create End-Item Manager applications to perform closed loop control of a specific End-Item system or component. A hierarchy of End-Item Managers might exist for large and complex End-Item Systems.

2.2.5.6.1 RTPS shall provide the capability to delegate and define closed loop control of one or more End-Items to an End-Item Manager.

2.2.5.6.2 The RTPS End-Item Manager function shall provide the capability to automatically safe the End-Item and continue if commanded when a RTPS system fault occurs.

2.2.5.6.3 RTPS shall provide the capability to delegate continuous End-Item monitoring to Constraint Management and respond to Constraint Management notification events.

2.2.5.6.4 RTPS shall provide the capability to operate an End-Item using rate based control.

2.2.5.6.5 RTPS shall provide the capability for an End-Item Manager Test Application to issue a command to another End-Item Manager Test Application.

2.2.5.6.6 RTPS shall provide the capability to alter the state of frame rate/time domain control based on an event.

2.2.5.6.7 RTPS shall provide priority Reactive Sequence control processing for End-Item Managers requiring minimum reaction time to Constraint Management notification events.

2.2.5.6.8 RTPS shall provide an End-Item control layer/encapsulation allowing maintenance in a single place and reuse through out user applications.

2.2.5.7 Test Application Scripts

The Test Application Script function provides a capability to define a sequence of events required for a given test.

2.2.5.7.1 CLCS shall provide a Test Application Script function for user test sequences.

2.2.5.7.2 The RTPS Test Application Script function shall provide the capability to automatically execute a sequence to safe the item under test when a RTPS system fault occurs.

2.2.5.7.3 The RTPS Test Application Script function shall provide the capability to continue, if commanded, after an automatic sequence to safe the item under test has occurred.

2.2.5.7.4 RTPS shall utilize Constraint Management for constraint monitoring for a Test Application Script.

2.2.5.7.5 Test Application Scripts shall be capable of issuing commands to End-Item Managers.

2.2.5.7.6 Test Application Scripts shall be capable of initiating other Test Application Scripts.

2.2.5.7.7 Test Application Scripts shall provide the capability to automate operations within an End-Item System.

2.2.5.7.8 Test Application Scripts shall provide the capability to automate integrated operations involving multiple End-Item Systems.

2.2.5.7.9 Test Application Scripts shall provide the capability to accept direct engineering input to confirm completion of manual operations.

2.2.5.7.10 Test Application Scripts shall provide the capability to allow multiple users to monitor Test Application Script execution.

2.2.5.7.11 Test Application Scripts shall be implemented in a manner that is clearly understandable and usable by system engineering and test management personnel and analogous to printed test procedures.

2.2.5.7.12 Test Application Scripts shall provide the capability to layer/encapsulate an End-Item System, allowing maintenance in a single place and reuse throughout user applications.

2.2.5.8 User Display

CLCS must provide a robust user display capability which allows user displays to be created without generating underlying user test applications. The CLCS must provide the capability to monitor measurements and display them in a variety of ways to the Shuttle Systems Engineer.

2.2.5.8.1 The CLCS shall provide the capability to monitor all measurement data available to the test set.

2.2.5.8.2 The CLCS shall provide the capability to display the current value of a measurement and all data related to the measurement.

2.2.5.8.3 The CLCS shall provide the capability to plot data from both real time acquisition of the data and data retrieved from the recording media.

2.2.5.8.4 CLCS shall provide the capability for users to define display applications that provide user manual End-Item control and visibility.

2.2.5.8.5 The RTPS User Display function shall provide the capability to read and display information derived from FDs.

2.2.5.8.6 The RTPS User Display function shall provide the capability to issue cursor control commands to FDs not managed by End-Item Managers

2.2.5.8.7 The RTPS User Display function shall provide the capability to issue cursor control commands to End-Item Managers

2.2.5.8.8 The RTPS User Display function shall provide the capability to initiate Test Application Scripts

2.2.5.9 User Advisory Expert System Applications

CLCS Advisory Expert System Applications will allow the user to create advisory applications to enhance the test engineers capability to detect faults and to predict future trends.

2.2.5.9.1 CLCS shall provide the capability to perform Advisory Expert System Applications.

2.2.5.9.2 RTPS Advisory Expert System Applications shall provide the capability to perform fault analysis.

2.2.5.9.3 RTPS Advisory Expert System Applications shall provide the capability to perform trend analysis.

2.2.6 USER APPLICATIONS REQUIREMENTS

User application requirements are not part of this release of the System Level Specification. These requirements will be included in a later version of this document and will be available for formal review at that time.

2.2.7 SAFING AND BIOMED REQUIREMENTS

The CLCS must provide a totally separate system that provides the capability to bypass the CLCS RTPS. This system is referred to as the CLCS Safing System and consists of two major areas: Vehicle and Hardwired Safing. Both areas have Safing Panels for their HCI. Hardwired Safing is connected directly to sensors and effectors at the test site (e.g., PAD, VAB, etc.). Vehicle Safing is connected to the LDB Gateway where Vehicle Safing Sequences are loaded and executed. Vehicle Safing is connected to the OFI PCM Downlink prior to the PCM Gateway in order to acquire measurement data to be displayed on the panels.

The CLCS must also provide a BIOMED capability for the display of astronaut biomedical data on the BIOMED console. The BIOMED data must be acquired from the OFI PCM Downlink prior to the PCM Gateway. The existing CCMS Vehicle Safing and BIOMED (VSB) Gateway will be utilized as the mechanism to acquire the PCM data for both Vehicle Safing and BIOMED. The BIOMED console will be incorporated into a RTPS workstation (TBD).

2.2.7.1 CLCS Safing

2.2.7.1.1 The CLCS Safing System shall provide a totally independent Safing capability for the emergency control and monitoring of critical and/or hazardous systems.

2.2.7.1.2 A separate Safing System shall be provided for every End-Item Site supported by the LCC Set (VAB1, VAB2, OPF1, OPF2, OPF3, PADA, PADB).

2.2.7.1.3 The CLCS Safing System shall provide the capability to place the Test Article and support equipment in a safe state.

2.2.7.1.4 The Safing System Shall support the generic console concept by providing an easily re-configurable Safing panel.

2.2.7.1.5 A Safing panel shall be provided at every command and control console position in the LCC Set.

2.2.7.2 Vehicle Safing

2.2.7.2.1 The CLCS Safing System shall provide the capability to execute Vehicle Safing Sequences that are initiated by the user on a Safing Panel at the User Console Position.

2.2.7.2.2 The CLCS Safing System shall provide a master enable function that enables one (or none) of the LDB Gateways to execute Vehicle Safing Sequences.

2.2.7.2.3 The CLCS Safing System shall support executing a Vehicle Safing Sequence in less than 100 milliseconds from user initiation to the start of the Safing Sequence execution.

2.2.7.2.4 The Active, Standby and Hot Spare LDB Gateways shall be capable of supporting Vehicle Safing.

2.2.7.2.5 The CLCS Safing System shall support a minimum of 32 predefined independent Vehicle Safing Sequences.

2.2.7.2.6 The CLCS Safing System shall provide the capability to Display PCM Downlink Safing data on Safing panels.

2.2.7.2.7 The CLCS Safing System shall provide the capability to enable/inhibit individual Vehicle Safing Sequences.

2.2.7.2.8 The CLCS Safing System shall provide the capability to load Vehicle Safing Sequences into an active Gateway without disrupting operation of that Gateway.

2.2.7.2.9 All activities in progress prior to a power failure, except for Vehicle Safing, shall be purged from the LDB Gateway when power is restored.

2.2.7.2.10 The LDB Gateway shall support Vehicle Safing within 8 seconds after power restoration.

2.2.7.3 Hardwire Safing

2.2.7.3.1 Hardwired Safing shall provide direct GSE effector control from the Safing System, bypassing the RTPS system.

2.2.7.3.2 Hardwired Safing feedback data shall be accomplished by GSE sensors returning hard-wired voltages directly to the Safing System, bypassing the RTPS system.

2.2.7.4 BIOMED

2.2.7.4.1 The RTPS shall provide the capability to Display OFI PCM Downlink BIOMED data at the BIOMED console position(s).

2.2.7.4.2 The RTPS shall not record the BIOMED data.

2.2.8 SYSTEM ENVIRONMENT REQUIREMENTS

The RTPS is used in two distinctly different types of environments; the Operational Environment and the Development Environment. Each of the different environments consists of different sets of hardware and satisfies different objectives. This section details the environments and their requirements.

2.2.8.1 Operational Environment

The Operational Environment is itself composed of two distinct types of hardware each of which is used in different ways.

1. Control Room Environments (i.e., LCC & Specialized Processing Sites)
2. Local Control Environment

2.2.8.1.1 Control Room Environments

The Control Room environment is one in which users use RTPS Workstations in rooms dedicated to the control and test of end items attached to the resources of the Test Set. These Control Rooms are used to control a wide variety of end items (e.g., Orbiters, Payloads, facilities equipment). The primary Control Rooms for CLCS is the LCC Set.

2.2.8.1.1.1 The CLCS shall provide a control room environment in which checkout and launch operations can take place in controlled areas.

2.2.8.1.1.2 The LCC Set shall be configurable into 8 separate Test Sets each of which can simultaneously perform different activities.

2.2.8.1.1.3 The LCC Set shall provide the capability to physically isolate critical Test Sets from other Test Sets.

2.2.8.1.1.4 The control room environment shall support the following operations:

1. Control of GSE and Orbiter in any OPF bay.
2. Control of GSE and Flight Vehicle in any Vertical Assembly Building (VAB) High Bay.
3. Control of GSE and Flight Vehicle at any KSC Launch Complex 39 Launch Pad.

The flexibility and versatility of the RTPS makes it suitable for process control of many facilities and end items other than the Space Shuttle. The RTPS control room environment is used in many areas other than the Launch Control Center both at KSC and other government facilities. These areas are called Specialized Processing Sites.

Typically a Specialized Processing Set contains much of the same hardware and software as the LCC Set. The main differences are quantities of equipment, and reduced redundancy. There are potentially additional requirements for the Specialized Processing Sites. These requirements, if any, are captured within the SLS in the following sections.

2.2.8.1.1.5 The CLCS shall provide a control room environment in which process control operations can take place in a controlled area for Specialized Processing Sites.

2.2.8.1.1.6 The CLCS shall provide the following Specialized Processing Sites:

1. Hypergolic Maintenance Facility (HMF)
2. Cargo Integrated Test Equipment (CITE)
3. Shuttle Avionics Integration Lab (SAIL)
4. Complex Control Set (CCS) — TBD

2.2.8.1.2 Hypergolic Maintenance Facility

The Hypergolic Maintenance Facility (HMF) is located in the KSC Industrial Area. It is used for off-line processing of the Orbital Maneuvering System (OMS) and Reaction Control System pods (RCS). The CLCS interfaces at HMF consist of GSE data buses, facilities (power, ground, etc.) and data networks back to LC-39. There are no PCM or LDB interfaces at HMF. The HMF Set does not contain redundant subsystem hardware and is not a configurable set. Safing is accomplished by powering down HIMs utilizing current CCMS Safing Panels.

2.2.8.1.3 Cargo Integrated Test Equipment

The Cargo Integrated Test Equipment (CITE) system simulates the interfaces between the Orbiter and the experiments in its cargo bay. CITE consists of a combination of hardware and software. The combination of the two is integrated to perform cargo to Orbiter Interface Verification Testing (IVT) prior to the installation of the cargo into the Orbiter cargo bay. The CITE system provides functional simulation of Orbiter avionics and power interfaces to the payload elements in the prelaunch, ascent and on-orbit configurations. CITE is designed to do this by verifying electrical and mechanical compatibility with the Orbiter and provide recovery time to repair incompatibilities. As sometimes more than one payload is carried on a flight, payload to payload compatibility is also verified. CLCS interfaces at CITE consist of OFI PCM, LDB, facilities (power, ground, etc.) and data networks back to LC-39. The CITE Set does not contain redundant subsystem hardware and is not a configurable set. There are no safing requirements for CITE.

2.2.8.1.4 Shuttle Avionics Integration Lab

The Shuttle Avionics Integration Laboratory (SAIL) is located at JSC. SAIL is used to perform interface testing between the CLCS equipment and software, and an actual flight-rated set of Orbiter avionics. SAIL consists of a CLCS set (also named SAIL) and the “rig” which is composed of a full set of Orbiter avionics and is used by KSC personnel to perform validation testing of the Orbiter hardware and software. The CLCS interfaces at SAIL consist of OFI PCM, SSME PCM, PCM Uplink, LDB, facilities (power, ground, etc.) and data networks back to KSC. There are no GSE interfaces at SAIL. The SAIL Set does not contain redundant subsystem hardware and is not a configurable set. There are no safing requirements for SAIL.

2.2.8.1.5 Complex Control Set

The existing Complex Control Set (CCS) is located in the KSC LCC and is used to monitor and control facility systems in the KSC LC-39 area. It is undetermined at this time if the CCS will be converted to be a part of CLCS.

2.2.8.1.6 Local Control Environment

The local control environment is one in which RTPS Human Computer Interface equipment is being used in the vicinity of the end item(s) under test. This proximity of a user interface to the end item allows for a consolidation of engineering resources. Support personnel may conduct non-hazardous operations at the location of the end item under test rather than requiring engineering resources both in the OCR and in the vicinity of the test article.

Local Operations will provide the capability to introduce specialized test unique equipment into the CLCS environment. This equipment may be required at various times during processing flow.

Local Subsystem Capabilities

2.2.8.1.6.1 RTPS shall provide the capability to acquire data from test equipment; monitor RTPS measurement data; and control test equipment and RTPS End Items in close proximity to the End Item (locally).

2.2.8.1.6.2 RTPS shall provide an easily portable subsystem (hand-carried by one person) for local acquisition and control operations.

2.2.8.1.6.3 RTPS shall provide the capability for the Local Acquisition and Control Subsystem (LACS) to operate in a standalone mode or as an integrated part of an RTPS Test Set (monitoring, commanding, recording, etc.).

2.2.8.1.6.4 RTPS shall provide the capability to time tag locally acquired measurement data and local commands.

Recording

2.2.8.1.6.5 RTPS shall provide the capability to record local commands and locally acquired measurement data on local media.

2.2.8.1.6.6 RTPS shall provide the capability for information recorded locally during standalone operations to be incorporated (post-test) with information recorded on the central CLCS recording subsystem.

Access Control

2.2.8.1.6.7 RTPS shall provide the capability for users in local environments to command/control any RTPS functions authorized for that user.

2.2.8.1.6.8 RTPS shall provide the capability to disable the command capability of non-local RTPS functions from a local workstation.

Video

2.2.8.1.6.9 RTPS shall provide the capability for local operations to use a video camera.

2.2.8.1.6.10 RTPS shall provide the capability to store video images for comparison purposes during local testing.

2.2.8.1.6.11 RTPS shall provide the capability to access stored video images at both local and control room workstations.

2.2.8.1.6.12 RTPS shall provide the capability for locally acquired video images to be displayed on both the local workstation and control room workstations.

2.2.8.2 Development Environments

The Development Environment is used primarily for software development, but integration of new hardware occurs in the development areas prior to being introduced into the operational environment. Systems integration and Test of hardware and software elements also occurs in the development environment. There are multiple areas where software development, integration, and test occur. Hardware and software adequate to perform the development is provided in each area.

2.2.8.2.1 System and Application Software Development Environment

The CLCS is required to provide an environment to allow development and testing of System and User Application Software. The environments where this development and testing occurs are the Satellite Development Environments. The SDEs provide a small subset of RTPS hardware which can be used for unit and preliminary integration testing of CSCIs and Test Applications.

2.2.8.2.1.1 The CLCS shall provide the following SDEs for development testing of System and User Application software:

- 1 2 - System Software SDEs
- 2 1 - Application Software SDE
- 3 1 - System Software SDE at JSC

2.2.8.2.1.2 The CLCS shall provide the capability to record and retrieve data to a local data store for debug purposes.

2.2.8.2.1.3 SDEs shall support Limited Configurations to allow multiple Test Sets to operate in parallel.

2.2.8.2.1.4 SDEs shall support Minimal Configurations to allow application development/debug on a single workstation.

2.2.8.2.2 Integrated Development Environment

The CLCS is required to provide a environment to allow validation of System and Application Software, and Hardware platforms in a resource stable environment. The environment where this integrated testing occurs is the Integrated Development Environment. The IDE provides a configuration that closely mimics an OCR. The Integrated Development Environments will provide the capability to verify and validate CLCS configuration items using a Simulation System. The Integrated Development Environment will use both operational configuration management as well as development configuration management guidelines and procedures within one controlled setting.

2.2.8.2.2.1 The CLCS shall provide the following IDEs for integration testing and validation of RTPS HWCIs and CSCIs.

- 1 1 - IDE without redundant hardware
- 2 1 - IDE with redundant hardware

2.2.8.2.2.2 The IDEs shall allow complete testing and validation of all delivered and integrated CSCIs and HWCIs.

2.2.8.2.2.3 IDEs shall support Limited Configurations to allow multiple Test Sets to operate in parallel.

2.2.8.2.2.4 IDEs shall support Minimal Configurations to allow application development/debug on a single workstation.

2.2.8.2.3 LCC-X

The CLCS is required to provide a environment to allow continued performance testing and analysis of ground support equipment. This environment which has both an operational and development role in CLCS is the LCC-X. The LCC-X will function as the early deployment test-bed for CLCS products and services as well as a laboratory for future vehicle processing support product study.

2.2.8.2.4 Applications Test-bed Environment

The CLCS must provide a development environment in which System and User Applications Developers can develop and debug their software without all of the equipment that will be required to run the program when it is placed in the operational environment. The capability must include simulation; however, this simulation capability does not need to have to run in real-time.

2.2.8.2.4.1 The CLCS shall provide an Application Test-bed Environment in which Systems and User Applications can be developed and debugged from office areas with minimal equipment.

2.2.9 SYSTEM CONTROL REQUIREMENTS

This section provides the requirements necessary to control the RTPS. Most of the requirements in this section provide the O&M User with the capability to control and manage the RTPS. It is organized similarly to the way the O&M Users control the system and contains subsections on:

1. Resource Management
2. Test Control and Progress Monitoring
3. System Integrity
4. Maintenance Functions

Much of the functionality in the System Control section is used to manage the resources in the LCC Set since this set is configurable into up to 8 smaller sets of hardware and software (Test Sets). These Test Sets may then be used to provide process control functionality of different facilities and end items.

2.2.9.1 Resource Management

Resource management is an activity that is typically accomplished in configurable sets (i.e., the LCC Set). It performs the initial allocation of resources and loading of software from the Set Master equipment in the Common Equipment Area (CEA). Once Test Sets are established within the LCC Set, control of the Test Set is

accomplished from the Test Set Master Equipment in the Test Set area. In non-configurable sets many of the functions of Resource Management are not active since the hardware is not available to provide configurable Test Sets in these sets.

2.2.9.1.1 The RTPS shall provide the capability to manage all equipment in an RTPS set.

2.2.9.1.2 The CLCS shall provide the capability, in each configurable RTPS set, to control/configure all of the equipment in the set that may be allocated to multiple parallel Test Sets.

2.2.9.1.3 The CLCS shall provide the capability to define a Test Set Activity which contains a list of the HW (e.g., network resources, subsystems, end item connectivity, etc.), and SW resources (e.g., SCID, TCID, etc.) needed to perform the activity.

2.2.9.1.4 Test Set Activities shall be capable of being pre-defined, stored for later use, and modified during use.

2.2.9.1.5 The RTPS shall provide a set of visual displays that provide comprehensive insight into the state and configuration of the set resources (e.g., network resources, subsystem assignments, software configuration, etc.).

2.2.9.1.6 The RTPS shall provide different views of test sets and activities in configurable sets (e.g., Master Set View, Test Set View, Activity View).

Setup and Allocation of Resources

2.2.9.1.7 The RTPS shall provide physical and electronic devices to permit configuration of end item links to the RTPS gateways.

2.2.9.1.8 The RTPS shall provide the capability to configure subsystem hardware to support a defined Test Set Activity physically and logically isolated from other Test Set Activities.

2.2.9.1.9 The RTPS shall provide the capability to assign network resources to processors within Gateway Groups, Control Groups, and Flow Zones (FZs).

2.2.9.1.10 The CLCS shall provide SW to assist in the configuration of the RTPS Test Set Hardware.

2.2.9.1.11 The RTPS shall provide a method to associate Gateway Groups with one or more Control Groups.

2.2.9.1.12 The RTPS shall provide a method to associate one or more Control Groups with a set of Workstation Positions to create a flow zone.

2.2.9.1.13 The RTPS shall provide the capability to configure users' workstations for selected activities

2.2.9.1.14 The RTPS shall provide the capability to monitor the current status of the assignment of network and processor resources.

SW Load and Distribution

2.2.9.1.15 The RTPS shall provide the capability to load and initialize the following Software in each subsystem of the Test Set:

1. Platform load
2. Subsystem Load (SCID)
3. Test SW Load (TCID)

2.2.9.1.16 The RTPS shall provide the O&M operator with the capability to select, load, monitor load progress, verify the load, and initialize all Software required in the Test Set.

2.2.9.1.17 The RTPS shall provide automated load capabilities for platform, subsystem, and test loads.

2.2.9.1.18 The RTPS shall provide the capability to verify the integrity of loaded software (i.e., presence, revision and CRC of required modules).

2.2.9.1.19 The RTPS shall provide the capability to verify the integrity of software loaded in a Test Set environment at any time.

2.2.9.2 Test Control and Progress Monitoring

Test Control and Progress Monitoring provides the O&M operator with the tools to control and monitor the status and health of a Test Set. Many of the tools provided by the requirements of Resource Management are also available in the Test Set area to augment capabilities provided by these requirements. For example the status displays provided by the requirements in Resource Management are available to perform Test Control and Progress Monitoring.

2.2.9.2.1 The RTPS shall provide Test Control and Monitoring for all subsystems in a Test Set.

2.2.9.2.2 The CLCS shall provide the capability to modify the hardware and software configuration of a Test Set during the execution of a test.

Monitoring and Control of Hardware and Software

2.2.9.2.3 The CLCS shall create a list of workstations, Subsystems, and network resources which will be allowed to participate in a named activity during the pre-configure activity.

2.2.9.2.4 The RTPS shall provide the capability to enable or disable commanding from any Gateway, CCP, or HCI.

2.2.9.2.5 The RTPS shall provide the capability to activate a test load.

2.2.9.2.6 The RTPS shall provide the capability to monitor each activity and determine what resources are participating in each activity.

2.2.9.2.7 The RTPS shall provide the capability to status and monitor the test configuration.

2.2.9.2.8 The RTPS shall provide a visual display depicting the health and status of all hardware resources within a Test Set and within all Test Sets of a Configurable Set.

2.2.9.2.9 The RTPS shall provide the capability to monitor the configuration of each subsystem participating in a test including what software is executing and any subsystem error conditions.

2.2.9.2.10 The RTPS shall provide a central point for the display of system error, status, and mode change messages.

2.2.9.2.11 The RTPS shall provide a central point for collection of LRU status and health.

Fault Detection and Isolation

2.2.9.2.12 The RTPS shall provide the capability to perform continuous fault detection and isolation of RTPS subsystem's hardware.

2.2.9.2.13 The RTPS shall provide a set of non-intrusive test programs to test interfaces and subsystem LRUs in the RTPS.

2.2.9.2.14 The RTPS shall provide the capability to scan all HIM outputs and confirm that they are the same as current commanded state.

Note: A capability called HIM Scan is provided to perform this requirement. It is used in a variety of situations:

1. To verify the status of commands on the HIMs are the same as those commanded by the RTPS.
2. It provides additional resources for recovery operations in the event of subsystem failures where automatic recovery doesn't occur.
3. It is also used in cases where HIMs have been powered up locally and commands have been issued.

Resource Utilization

2.2.9.2.15 The RTPS shall provide the capability to continuously monitor subsystem resource utilization in all

RTPS subsystems.

2.2.9.2.16 The RTPS shall provide alarm messages when resource utilization levels exceed pre-defined limits.

2.2.9.2.17 The RTPS shall provide the capability to control the pre-defined limits of the subsystem resources that are being monitored.

2.2.9.3 System Integrity

System Integrity and Redundancy Management are provided through several functions executing in the RTPS. These functions are available in all sets, however, redundancy does not work unless hardware and software resources are available and configured properly. System Integrity provides the main portion of redundancy management within the RTPS.

2.2.9.3.1 The RTPS shall provide redundancy management of all redundant subsystems and network resources in a Test Set.

Redundancy Management

2.2.9.3.2 The RTPS shall provide a central point to coordinate and direct redundant element activation (known as System Integrity).

2.2.9.3.3 System Integrity shall be capable of being run from any Console Position within a Test Set.

2.2.9.3.4 A redundant copy of System Integrity shall exist for use during critical control situations.

2.2.9.3.5 The RTPS shall provide a method to share current configuration data with a redundant element.

2.2.9.3.6 The RTPS shall provide a method to track redundant element states.

2.2.9.3.7 System Integrity shall monitor critical subsystems for failure and in the event a monitored subsystem fails, shall perform a switchover to the standby subsystem.

2.2.9.3.8 System Integrity shall report all subsystem errors to a central point.

2.2.9.3.9 The CLCS shall provide a reduced capability mode in which a Test Set continues to support even though all copies of System Integrity fail.

Note: Functions that are not supported or whose capability is reduced in the reduced capability mode are:

1. Redundant Element Switchover
2. Test Set Resource Monitoring
3. Checkpointing
4. Restarting subsystems

2.2.9.3.10 The CLCS shall provide a “warm boot” capability in which System Integrity can be restored after failure.

2.2.9.3.11 After a “warm boot” System Integrity shall restore normal function to those capabilities which were reduced while in the reduced capability mode.

Rationale: In the CCMS, the System Configuration Table (SCT) is maintained in the Master Console memory, Integration Console memory, and the CDBFR (copies are also maintained in each CPU). The SCT contains the current system configuration information (e.g., logical port to physical port addressing information, subsystem status). For a CCMS set to be fully operational, it must have an operating Master Console. If the Master Console fails, the Integration Console, where available, picks up the Master Console’s functions. If the Integration Console also fails or isn’t present when a Master Console fails, the system will continue to operate in a degraded mode. When the Master Console is brought back on line it is “Warm Booted”; it reads the SCT from the CDBFR and uses the CDBFR SCT as the correct SCT. The CLCS needs to preserve many of these functions and capabilities (even though no CDBFR exists in the CLCS and the SCT may not exist).

2.2.9.3.12 After a “warm boot”, the RTPS shall be restored to normal function.

2.2.9.3.13 After a “warm boot”, the RTPS shall be capable of restoring to a checkpointed function.

Checkpoint Restart

2.2.9.3.14 The RTPS shall provide a method to store current configuration data,

2.2.9.3.15 The RTPS shall provide a method, in real-time, to make updates to stored configurations.

2.2.9.3.16 The RTPS shall provide a method to restore previously stored configuration data.

2.2.9.4 Maintenance Functions

The Maintenance Function is dedicated for Organizational Level maintenance use. It provides O&M personnel with Operational Readiness Tests, and monitoring and diagnostic tools to maintain the HW and SW in the RTPS.

2.2.9.4.1 The RTPS shall provide a Maintenance Function for each subsystem in a Test Set.

Maintenance Monitoring

2.2.9.4.2 The Maintenance Function shall provide SW necessary to integrate and interpret operational and maintenance messages from the following areas:

1. System messages
2. Subsystem health and status information
3. RTCN and DCN network statistics and configurations
4. ORT results
5. Console port subsystem boot and error messages
6. Data from commercial network sniffers/analyzers

2.2.9.4.3 The Maintenance Function shall provide maintenance trend analysis and failure prediction capabilities.

2.2.9.4.4 The RTPS shall be able to run intrusive and non-intrusive diagnostics on any subsystem and on multiple subsystems concurrently.

2.2.9.4.5 The CLCS shall provide a recommended fault isolation tree.

Interface Validation

2.2.9.4.6 The RTPS shall be able to test subsystem LRU interfaces.

2.2.9.4.7 The RTPS shall be able to test each external interface.

Operational Readiness Testing (ORT)

2.2.9.4.8 The RTPS shall provide a set of Operational Readiness Tests (ORTs) that determine the readiness of any Test Set (System Level ORT) to support the activities defined for it.

2.2.9.4.9 The RTPS shall provide comprehensive ORTs that determine the readiness of any subsystem (Subsystem Level ORT) to support the activities defined for it.

Diagnostics

2.2.9.4.10 All LRUs and subsystems shall have a Power on Self Test (POST).

2.2.9.4.11 Diagnostics shall provide a visual indication of running and completion.

2.2.9.4.12 The RTPS shall provide a set of off-line programs to test the system hardware

2.2.10 RTPS RECORDING AND RETRIEVAL REQUIREMENTS

The RTPS records all actions initiated by the User and System or User Applications that result or potentially result in changes to end item, communication between subsystems, changes in system state, and changes to system health. In addition all incoming and outbound messages to any of the external interfaces are recorded. Recording

is normally accomplished to the SDC; however, limited recording to local storage media is also accomplished. The RTPS also provides the capability to retrieve data recorded to the SDC for use at the user workstations.

2.2.10.1 RTPS Recording Requirements

2.2.10.1.1 The RTPS shall record user actions that result or potentially result in changes to the state of the system (e.g., initiation of a program, issuing commands, program prompts and their responses, control panel switch changes, program text information messages, etc.).

2.2.10.1.2 RTPS inter-process communication between User Applications shall be recorded to the SDC.

2.2.10.1.3 The RTPS shall record all inter-subsystem messages to the SDC.

2.2.10.1.4 The RTPS shall time tag all data with 100 microsecond tags for recording purposes.

Measurement and Command Processing

2.2.10.1.5 The RTPS shall record all measurement changes along with the health and sample time to the SDC.

2.2.10.1.6 The RTPS shall record all commands and command responses to the SDC.

2.2.10.1.7 The RTPS shall record all Fused Data FD and Fused FD parameter changes to the SDC.

2.2.10.1.8 The RTPS shall record all Pseudo FD changes to the SDC.

2.2.10.1.9 The RTPS shall record all measurement health changes to the SDC.

2.2.10.1.10 The RTPS shall record all Constraint Management violation events to the SDC.

2.2.10.1.11 All messages sent to and received from the Constraint Manager shall be recorded to the SDC.

Miscellaneous System Services

2.2.10.1.12 The RTPS shall provide the capability to record screen captures to the SDC.

2.2.10.1.13 The RTPS shall record selected keyboard and pointing device actions to the SDC.

2.2.10.1.14 The RTPS shall record each step executed in a Test Application Script to the SDC.

2.2.10.1.15 The RTPS shall record all messages sent to and received from the Constraint Manager to the SDC.

2.2.10.1.16 The CLCS shall provide the capability for System and User Applications to record data to the SDC.

2.2.10.1.17 The RTPS shall provide the capability to System and User Applications to record limited messages on the local computer's hard file storage device.

2.2.10.1.18 The RTPS shall provide the capability to record locally recorded data to the SDC.

2.2.10.1.19 The RTPS shall record all attempts to log on to a workstation to the SDC.

2.2.10.1.20 The RTPS shall record all System Messages to the SDC.

System Control

2.2.10.1.21 The RTPS shall record all configuration information to the SDC.

2.2.10.1.22 The RTPS shall record all communications to the Maintenance Monitor function to the SDC.

2.2.10.1.23 The RTPS shall record all System Integrity communications to the SDC.

2.2.10.1.24 The RTPS shall record resource utilization data for off-line analyses.

2.2.10.1.25 The RTPS shall record all real-time diagnostics messages to the SDC.

2.2.10.1.26 The RTPS shall record all performance monitor messages and alerts to the SDC.

2.2.10.2 Retrieval Requirements

2.2.10.2.1 The RTPS Shall provide the capability for System and User Applications to retrieve near-real-time and archived data from the SDC.

2.2.10.2.2 The CLCS shall provide the capability to plot data retrieved from the SDC.

2.2.11 RELIABILITY, MAINTAINABILTY, AND AVAILABILITY REQUIREMENTS

2.2.11.1 Reliability

2.2.11.1.1 The total RTPS hardware provide by CLCS (no HIMs, Power, Lights, External V&DA) shall require a low level of maintenance actions. Under 300 subsystem hardware repairs shall be required per year.

Reliability	Units Total	Failures Per Year	MTBF Hours	Unit MTBF Hours
Work Stations	600	200	43.8	26,280
Control Group Subsystems	100	30	292	29,200
Front End Group Subsystems	180	50	175.2	31,536

2.2.11.2 Maintainability

The following requirements apply to COTS and Custom hardware

2.2.11.2.1 All maintenance actions shall be able to be performed without removing rack or cabinet side panels.

2.2.11.2.2 LRUs shall be replaceable by one person without special tools.

2.2.11.2.3 Minimal disassembly shall be required for preventive maintenance activities.

2.2.11.2.4 Cable removal shall not require special tools.

2.2.11.2.5 External ribbon style connectors shall utilize locking devices.

2.2.11.2.6 External cables shall have adequate service loops and use part number and "mates with" labeling convention.

2.2.11.2.7 Parts shall be keyed for proper assembly.

2.2.11.2.8 Fault indicators, fuses, and circuit breakers shall have plain English annotations.

2.2.11.2.9 External cables shall be routed so they are not pinched by doors, covers, etc. Sharp bends shall be avoided.

2.2.11.2.10 External plug and receptacles shall be labeled correctly.

2.2.11.2.11 LRUs shall utilize quick disconnects in lieu of soldered connections.

2.2.11.2.12 Power phasing requirements shall be clearly marked.

2.2.11.2.13 Cooling fans/filters shall be easily removed with minimal disturbance to the system.

2.2.11.2.14 A minimum of eight AC utility outlets shall be provided on all rack assemblies, four in the front and four in the rear.

2.2.11.2.15 If extender boards are required for servicing, adequate service loops for front card edge cabling shall be provided.

The following requirements apply to Custom hardware.

2.2.11.2.16 All Orbiter/GSE signal paths shall be capable of being monitored without opening racks or disrupting the signal path.

2.2.11.2.17 Tests and adjustments shall be able to be made without LRU removal.

2.2.11.2.18 LRU test point and scope ground connections shall be located on the accessible side of the LRU.

2.2.11.2.19 Ground connection test points shall not be adjacent to the Vcc plane.

2.2.11.2.20 LRUs shall have component designations and test point information silk screened on both sides of the printed circuit board.

2.2.11.2.21 LRU Ground and Vcc planes shall be clearly marked

2.2.11.2.22 Status of LEDs shall be visible without removing equipment covers or breaking seals.

2.2.11.3 Availability

2.2.11.3.1 A LCC Test Set's hardware shall be available to support, with no equipment down and without allocating other Test Set Equipment, 99.3 % of the time assuming a 4 hour Mean Time To Repair (MTTR).

Availability of LCC Test Set	Units Available	Units Needed	Unit MTBF Hours	Unit Failure Rate	Subsystem Failure Rate
Position 5 Work Stations	45	45	26,280	0.0076104	0.342465753
Control Group Subsystems DDP	3	3	29,200	0.0342466	0.102739726
Control Group Subsystems CCP	8	8	29,200	0.0342466	0.273972603
Front End Group PCM	3	3	31,536	0.0317098	0.095129376
Front End Group SSME	3	3	31,536	0.0317098	0.095129376
Front End Group GSE 1	3	3	31,536	0.0317098	0.095129376
Front End Group GSE 2	3	3	31,536	0.0317098	0.095129376
Front End Group GSE 3	3	3	31,536	0.0317098	0.095129376
Front End Group LDB	3	3	31,536	0.0317098	0.095129376
Front End Group Other	3	3	31,536	0.0317098	0.095129376
Total					1.385083714
Period Hours					1000
MTTR Hours					4
Availability of LCC Test Set					99.4460%

2.2.11.3.2 A Specialized LCC Test Set's hardware shall be available to support, with no equipment down and without allocating other Test Set Equipment, 99.5 % of the time assuming a 8 hour Mean Time To Repair (MTTR).

Availability of HMF Test Set	Units Available	Units Needed	Unit MTBF Hours	Unit Failure Rate	Subsystem Failure Rate
Position 5 Work Stations	4	4	26,280	0.0076104	0.0304414
Control Group Subsystems DDP	2	2	29,200	0.0342466	0.068493151
Control Group Subsystems CCP	2	2	29,200	0.0342466	0.068493151

Availability of HMF Test Set	Units Available	Units Needed	Unit MTBF Hours	Unit Failure Rate	Subsystem Failure Rate
Front End Group GSE 1	2	2	31,536	0.0317098	0.063419584
Front End Group GSE 2	2	2	31,536	0.0317098	0.063419584
				Total	0.29426687
				Period Hours	1000
				MTTR Hours	8
				Availability of HMF Test Set	99.7646%

2.2.11.4 Probability of Mission Success

2.2.11.4.1 A LCC Test Set's hardware shall have a probability of success while supporting critical operation for a period of a 100 hour test without repair actions of 99.99%. This is defined as having both active and standby subsystems of each type available during this period.

Probability of LCC Test Set Supporting Critical Operation	Units Available	Units Needed	Unit MTBF Hours	Unit Failure Rate	Subsystem Failure Rate
Position 5 Work Stations	45	30	26,280	0.000761	
Control Group Subsystem DDP	3	2	29,200	0.0034247	1.17283E-05
Control Group Subsystem CCP	8	6	29,200	0.0034247	1.17283E-05
Front End Group PCM	3	2	31,536	0.003171	1.00551E-05
Front End Group SSME	3	2	31,536	0.003171	1.00551E-05
Front End Group GSE 1	3	2	31,536	0.003171	1.00551E-05
Front End Group GSE 2	3	2	31,536	0.003171	1.00551E-05
Front End Group GSE 3	3	2	31,536	0.003171	1.00551E-05
Front End Group LDB	3	2	31,536	0.003171	1.00551E-05
Front End Group Other	3	2	31,536	0.003171	1.00551E-05
				Total	9.38423E-05
				Period Hours	100
				MTTR Hours	N/A.
				Probability of LCC Test Set To Support Critical Operation	99.9906%

2.2.11.4.2 A LCC Test Set's hardware shall have a probability of success while supporting launch operation for a period of a 1 hour test without repair actions of 99.9999%. This is defined as no critical failures of both the active and standby subsystems of each type during this period.

Probability of No Critical Failure LCC Test Set	Units Available	Units Needed	Unit MTBF Hours	Unit Failure Rate	Subsystem Failure Rate
Position 5 Work Stations	45	15	26,280	7.61E-06	
Control Group Subsystem DDP	3	1	29,200	3.425E-05	4.01653E-14
Control Group Subsystem CCP	8	4	29,200	3.425E-05	3.76856E-22
Front End Group PCM	3	1	31,536	3.171E-05	3.18845E-14
Front End Group SSME	3	1	31,536	3.171E-05	3.18845E-14
Front End Group GSE 1	3	1	31,536	3.171E-05	3.18845E-14
Front End Group GSE 2	3	1	31,536	3.171E-05	3.18845E-14
Front End Group GSE 3	3	1	31,536	3.171E-05	3.18845E-14
Front End Group LDB	3	1	31,536	3.171E-05	3.18845E-14
Front End Group Other	3	1	31,536	3.171E-05	3.18845E-14
				Total	2.63357E-13
				Period Hours	1

Probability of No Critical Failure LCC Test Set	Units Available	Units Needed	Unit MTBF Hours	Unit Failure Rate	Subsystem Failure Rate
				MTTR Hours	N/A
				Probability of No Critical Failure LCC Test Set	100.0000%

2.2.11.4.3 A Specialized Test Set's hardware shall have a probability of success while supporting critical operation for a period of a 100 hour test without repair actions of 99.95%. This is defined as having a subsystems of each type available during this period.

Probability of HMF Test Set Supporting Critical Operation	Units Available	Units Needed	Unit MTBF Hours	Unit Failure Rate	Subsystem Failure Rate
Position 5 Work Stations	4	2	26,280	0.000761	5.79174E-07
Control Group Subsystem DDP	2	1	29,200	0.0034247	1.17283E-05
Control Group Subsystem CCP	2	1	29,200	0.0034247	1.17283E-05
Front End Group GSE 1	2	1	31,536	0.003171	1.00551E-05
Front End Group GSE 2	2	1	31,536	0.003171	1.00551E-05
				Total	4.4146E-05
				Period Hours	100
				MTTR Hours	N/A.
				Probability of HMF Test Set Supporting Critical Operation	99.9956%

2.2.12 HUMAN FACTORS REQUIREMENTS

This section defines the human factors guidelines necessary to ensure that the design of the CLCS enhances safety, productivity, and comfort and minimizes errors, fatigue, and stress. These requirements are not intended to preclude the use of COTS products. They are to be used as criteria for selection among COTS products, when available. When fully-compliant COTS products are not available, requirements cost/benefit analyses shall be performed of COTS vs. non-COTS solutions.

2.2.12.1 Hardware Considerations

2.2.12.1.1 The workstation and associated controls shall accommodate the physical and visual capabilities of the population based on anthropometry data for the range from the 5th percentile female to the 95th percentile male.

2.2.12.1.2 Equipment shall be designed to preclude personnel hazards, injury, accidental shock to operators (minimized for maintenance personnel), and damage to clothing.

2.2.12.1.3 Display/control equipment and hardcopy-producing devices shall be designed so maintenance activities may be performed expediently and with minimal interference to workstation operators; safely; accurately; and with minimum requirements for personnel, skills, special tools, and cost.

2.2.12.1.4 Equipment and other peripheral devices shall be designed so maintenance activities may be performed expediently and with minimal interference to workstation operators; safely; accurately; and with minimum requirements for personnel, skills, special tools, and cost.

2.2.12.1.5 Whenever an operator must use a large number of controls and displays, their location and arrangement shall be designed to aid in determining which controls are used with which displays, which equipment component each control affects, and which equipment component each display describes.

2.2.12.1.6 For standing operations, work surfaces to support items such as job instruction manuals, worksheets, and logbooks shall be 35 +/- 0.6 inches above the standing surface, unless otherwise specified.

2.2.12.1.7 For seated operations, provisions shall be made for vertical seat adjustment from 15 to 21 inches in increments of no more than 1 inch each.

2.2.12.2 Environmental Effects

2.2.12.2.1 Equipment finishes and surfaces shall be designed to minimize glare and specular reflections.

2.2.12.2.2 The thermal design of workstations and equipment shall preclude "hot spots" (surface temperatures exceeding 45° C, 113° F).

2.2.12.2.3 Computer peripherals and other equipment located in user areas shall not emit noxious (harmful or irritating) fumes or particulate matter.

2.2.12.3 Human Computer Interface

2.2.12.3.1 The Graphical User Interface (GUI) shall conform to the look and feel contained in the OSF/Motif Style Guide.

2.2.12.3.2 Displays and controls shall follow the user interface guidelines specified in the CLCS HCI Guidelines and Standards (**DOC# - TBD**).

Note: The above referenced document contains guidelines and standards on many of the aspects of screen displays. For example:

1. Menus and Layout
2. User Inputs
3. Feedback to User
4. Status and Error Messages
5. Alarms and their management
6. Display Characteristics

This note will be removed after ABR.

2.2.12.4 Command Panels

Command Panels are I/O devices that provide information to, and receive from, Console Position users. Applications may display information to the Command Panel and accept discrete inputs from the users via Control Panel push buttons. All Console Positions which provide command and control capabilities, such as in the Operations Control Rooms (OCR) and Multi-function Rooms (MFR), must provide Command Panels.

2.2.12.4.1 The Command Panel shall provide the Safing functionality of the CCMS Programmable Function Panel (PFP).

2.2.12.4.2 The CLCS shall provide a clear and unambiguous association between the Command Panel actions and the functions provided by the Command Panel buttons.

2.2.12.5 Operational Television (OTV)

Since the OTV system and the RTPS are separate systems the only requirements in the CLCS for OTV are to provide space, power, and cooling in the Console Position equipment.

2.2.12.5.1 The RTPS shall provide space, power, and cooling in the Console Position for TBD OTV displays.

2.2.12.5.2 The RTPS shall provide the capability after user test applications to command a specific camera to be selected for a specific OTV screen with preset position and zoom parameters.

2.2.12.6 I/O Devices

Each RTPS Set contains common I/O areas called Shared I/O Areas that are physically located in the vicinity of the user Consoles. There are two Shared I/O areas in each of the LCC OCRs that are isolated and on separate UPS power sources so that a single failure will not force a major interruption of operations.

2.2.12.6.1 Each Shared I/O Area shall contain one or more color page scanners, Fax machines, high quality black and white printers, color printers, and photo quality color printers.

2.2.12.6.2 The CLCS shall provide the capability to spool output from any Console Position to any of the output devices in the Shared I/O Area in that OCR.

2.2.12.6.3 The RTPS shall provide three separate shared I/O areas in each LCC Set OCR.

1. Operations support (2 ea)
2. Management row support (1 ea)

2.2.12.7 Facilities

This section will contain facilities human factors requirements (e.g., lighting, humidity, floor covering, etc.)

2.2.13 SAFETY AND SECURITY REQUIREMENTS

2.2.13.1 Safety Requirements

2.2.13.1.1 High voltage areas shall be clearly marked and shielded to prevent accidental contact.

2.2.13.1.2 High current power supply outputs shall be clearly marked and shielded to prevent accidental contact.

2.2.13.1.3 Safety covers shall be non-conductive if there is insufficient metering or adjustment clearances.

2.2.13.1.4 Power supplies shall be adjustable and measurable without removing safety covers.

2.2.13.1.5 All fans, gears, pulleys, and other moving parts shall be shielded and clearly marked.

2.2.13.1.6 Rack slides shall have safety catches to prevent over extension.

2.2.13.1.7 Doors and panels shall swing out of the working area or be removable.

2.2.13.1.8 If a sub-assembly must be moved to gain access during maintenance, troubleshooting, or repair of the system, it shall have restraining hardware to keep it secured and out of the way.

2.2.13.1.9 All laser devices shall be shielded and clearly marked.

2.2.13.1.10 All developed hardware shall be designed with receptacles "hot" and plugs "cold".

2.2.13.2 Security Requirements

2.2.13.2.1 The RTPS shall be physically isolated from all inbound communications other than those specified in section 2.1.1 External Systems Interface Requirements.

2.2.13.2.2 The CLCS shall provide a mechanism to prevent inadvertent issuance of commands from a console position or a local control device by an unauthorized system user.

2.2.13.2.3 The CLCS shall provide protection from malicious intrusion due to computer Software viruses.

2.2.13.2.4 The CLCS shall adhere to all agency and KSC specific security guidelines.

2.2.14 DESIGN AND CONSTRUCTION REQUIREMENTS

The design and construction requirements presented in this section address the system level general hardware design requirements for the CLCS. These requirements are imposed on the design of the system to maximize safety, reliability, commonality, maintainability, and usability. The design requirements and criteria specified in this section are applicable for all CLCS provided equipment.

2.2.14.1 Underwriters Laboratory Certifications & Approval

2.2.14.1.1 Commercial equipment utilized in CLCS shall be compliant with either Underwriters Laboratory Specification 1950 or the International Equipment Consortium (IEC) Specification 950 for product safety.

2.2.14.1.2 Vendors shall provide the results of UL 1950 or IEC 950 compliance testing upon request.

2.2.14.2 Acoustics

2.2.14.2.1 The acoustical noise level of any subsystem shall comply with MIL-STD-1472.

2.2.14.3 Operating Environment

2.2.14.3.1 CLCS equipment shall operate within an ambient temperature of 10° C (50° F) to 32° C (90° F).

2.2.14.3.2 CLCS equipment shall operate within a relative humidity range of 20% to 80%, non-condensing.

2.2.14.4 Non -Operating Environment

2.2.14.4.1 CLCS equipment shall be designed to be stored within an ambient temperature of -17° C (0° F) to 49° C (120° F).

2.2.14.4.2 CLCS equipment shall be designed to be stored within a relative humidity range of 10% to 80%, non-condensing.

2.2.14.5 Altitude

2.2.14.5.1 No operational altitude requirements exist for CLCS, other than that CLCS equipment shall operate nominally in all currently identified deployment locations at KSC, JSC and DFRC.

2.2.14.5.2 CLCS equipment shall be capable of operating normally, after being subjected to basic transportation as secured cargo by land, sea or air.

2.2.14.6 Temperature

2.2.14.6.1 Rack-mounted CLCS equipment shall operate with a forced air temperature between +60° and +80° F as measured at the air input at the base of the rack with extremes of uncontrolled temperatures between 52° and 105° for one (1) hour.

2.2.14.6.2 Rack-mounted CLCS equipment shall operate with a temperature rise not exceeding 18° F as measured between the air input at the base of the rack and the air output at the top of the rack.

2.2.14.6.3 Non-rack-mounted equipment (DDP, CCP, Workstations, etc.) shall be designed to operate in an air conditioned environment with the ambient room temperatures between +60° to +80° F with extremes of uncontrolled temperatures between 52° and 105° for one (1) hour.

2.2.14.7 Physical Power

2.2.14.7.1 CLCS equipment utilizing 115 VAC power shall be plugged into rack-resident Power Distribution Panels (PDPs) where feasible.

2.2.14.7.2 The CLCS PDPs shall be plugged into 208 VAC 3-Phase underfloor facility power with NEMA-style L21-30P or L5-30P connectors.

2.2.14.8 Operating Supply Voltage

2.2.14.8.1 CLCS equipment utilizing 115 VAC power shall operate normally within the ranges of 100 VAC to 130 VAC and 57HZ to 63Hz.

2.2.14.8.2 CLCS equipment utilizing 208 VAC power shall operate normally within the range of 200 VAC to 230 VAC.

2.2.14.9 Grounding

All CLCS equipment shall be referenced (via the green safety ground wire in its power plug) to the single-point ground in the facility where they are installed.

2.2.14.10 Electromagnetic Interference

2.2.14.10.1 Commercial equipment utilized in CLCS that is sold in the United States shall be compliant with FCC Class A specifications for electromagnetic emissions.

2.2.14.10.2 Custom-designed equipment utilized in CLCS will be subjected to MIL-STD-461/462 testing to identify potential electromagnetic compatibility problems.

2.2.14.11 Electromagnetic Compatibility

NOTE: Electromagnetic interference is highly dependent upon the facility where the equipment is located, the orientation of the equipment, communication frequencies and many unpredictable factors. Prior to the turnover of all CLCS sets of equipment, EMI emissions checks will be performed on-site to identify any potential problems that exist. If deemed appropriate by engineering judgment, common EMI preventative measures (gasketing, fingerstock, in-line filters, ferrules, etc.) will be employed to reduce or alleviate the problem.

2.2.14.12 Electrostatic Discharge

2.2.14.12.1 Each rack-mounted subsystem shall withstand an electrostatic discharge of 12.5 kilovolts through 280 picofarads and 600 ohms on any exterior cabinet surface with no loss of data integrity within the system or subsystem.

2.2.14.13 Protective Coatings and Finishes

2.2.14.13.1 Commercial equipment utilized in CLCS that is sold in the United States shall use protective coatings and finishes in accordance with the suppliers standard commercial practices.

2.2.14.13.2 Commercial equipment with deficiencies in its protective coatings (i.e., an unpainted aluminum housing) shall be disqualified for use in CLCS

2.2.14.13.3 Custom-designed equipment used in CLCS that contains bare aluminum shall have that aluminum treated per MIL-STD-171, Class 1A, finish 7.3.3 (irridite).

2.2.14.13.4 Custom-designed equipment used in CLCS that contains bare steel shall have that steel treated per ASTM specification B633, SC2, type II (zinc-plated).

2.2.14.13.5 All painted surfaces shall utilize primers and high-quality enamel or latex paints.

2.2.14.13.6 The actual colors employed, shall be based upon FED-STD-595.

2.2.14.13.7 No wood-based or other flammable materials shall remain exposed in CLCS subsystems or equipment.

2.2.14.14 Dissimilar Metals and Corrosion Control

2.2.14.14.1 Metal parts utilized in CLCS equipment shall be treated (per MIL-STD-171) to resist corrosion if they are to be used with other (dissimilar) metals.

2.2.14.15 Fungus Resistance

2.2.14.15.1 Where feasible, materials used in the construction of commercial and custom-designed CLCS equipment shall be either fungus resistant or treated to resist fungus.

2.2.14.15.2 Commercial equipment that is susceptible to fungus and cannot be made fungus resistant shall be disqualified for use in CLCS.

2.2.14.16 System Cable Numbering

2.2.14.16.1 System cables utilized in CLCS will receive a “W” identifying number that uniquely identifies each cable.

2.2.14.16.2 All system cables will be identified in the appropriate CLCS cable interconnect diagram(s).

2.2.14.17 Serialization and Bar Code Labeling

For accountability and traceability purposes, each unique classification of equipment (assembly number or specification number) used in CLCS that is valued over \$250 will be assigned a unique serial number.

2.2.14.17.1 For commercial equipment, the rules specified in KSC NHB 4200.2 shall apply.

2.3 BUSINESS AND INFORMATION NETWORK

The Business and Information Network (BIN) provides RTPS workstation connectivity and access to non-RTPS applications and data such as Orbiter cable and connector information, E-Mail, documentation, drawings, etc. Refer to the table below for the supported external applications and their function. Access to these applications and their information is provided via computing resources in the CLCS that are available at the Console Position.

2.3.1 BUSINESS AND INFORMATION NETWORK REQUIREMENTS

2.3.1.1 The Business and Information Network shall provide access to external systems via a network separate from the Command and Control Network.

2.3.1.2 The Business and Information Network shall provide the software tools necessary to retrieve, display, update, and print information available on external computing systems.

2.3.1.3 The Business and Information Network shall support monitoring up to four concurrent Test Set activities.

2.3.1.3.1 The Business and Information Network shall allow user access to the SDC for retrievals.

2.3.1.4 The Business and Information Network shall provide the following office capabilities.

1. Word Processing
2. Spread Sheet
3. Drawing Tool

Rationale: There is a variety of computing systems at KSC and other NASA centers that contain information of value to personnel in the OCRs. Access to this data in a timely manner will help to minimize the labor force required to checkout and launch the Space Shuttle. The following kinds of information will be available from the external systems:

External Element	Function
E-Mail	Communication
Expert Systems (e.g., KATE, PSA, DLES, IAPU) and Integration Tools	
FTP	File Transfers
Goody Books	Reference Material
IWCS	Work Control, Scheduling, Requirements Tracking, Work Authorization Documentation
JSC	Reference Material
KEDS	Electronic Drawings
LANs	
MFSC	Reference Material
OMI	Operations/Maintenance Instructions
Operations Notes	Reference Material
PCGOAL	Monitor Displays
PRACA	Problem/Correction Information
SCAN	Cable and Connector Information
SDC	Retrievals
SDS	Monitor Displays
SECAS	
SIMS	Pictures
System Help	Reference Material
X-Term	Terminal Emulation
WWW/Internet	General Business

2.4 SHUTTLE DATA CENTER

The SDC is the portion of the CLCS that provides off-line processing for other subsystems in the CLCS. It is used to prepare software for use in the CLCS, to store data which has been processed by the RTPS, and provide a retrieval capability for the data that has been previously stored. This system is similar to the CDS in the LPS. SDC also contains the CLCS Configuration Management Environment which is the primary repository for all CLCS strategic computer file products including software, documentation, drawings, schedules and tracking of all strategic non-computer file products.

2.4.1 SHUTTLE DATA CENTER REQUIREMENTS

2.4.1.1 The SDC shall provide a repository for and access to COTS products used by CLCS Support Software.

2.4.1.2 The SDC shall provide a repository for and access to Development Environment capabilities necessary for supporting day to day development operations.

2.4.1.3 The SDC shall provide a repository for and access to CLCS Support Software via Hyper-Text Transfer Protocol.

2.4.1.4 The SDC shall provide a repository for and access to the CLCS Configuration Management Environment.

2.4.1.5 The SDC shall provide a repository for and access to the CLCS System Build Software.

2.4.1.6 The SDC shall provide a repository for and access to the CLCS Test Build Software.

2.4.1.7 The SDC shall provide a repository for and access to the CLCS Test Build Databases.

2.4.1.8 The SDC shall provide RTPS read access to all CLCS software code, and technical documents.

2.4.2 TEST BUILD REQUIREMENTS

The SDC provides a means of supporting test definition, test build, load, and activation of a Target RTPS Set that has been loaded with a System Build load. Test Build utilizes the CLCS Configuration Management Environment to manage and select build input data.

2.4.2.1 The SDC shall provide a central repository of Function Designator information.

2.4.2.2 The SDC shall provide a means of managing the Function Designator data housed in the repository.

2.4.2.3 The SDC shall provide a means of managing executable Application Software housed in the CLCS Configuration Management Environment.

2.4.2.4 The SDC shall provide a means of defining the criteria for the selection of data to be included in the test load.

2.4.2.5 The SDC shall provide a temporary repository to contain the data selected for inclusion in the test load.

2.4.2.6 The SDC shall provide a means of building the non-executable data loads required by the RTPS, such as Gateway tables, Online Data Bank, etc.

2.4.2.7 The SDC shall provide a means of building the executable data loads required by the RTPS, such as CCP End Item Managers, HCI User Displays, etc.

2.4.2.8 The SDC shall provide a means of defining which System Builds are usable for a Test Build Load.

2.4.3 SYSTEM BUILD REQUIREMENTS

The SDC provides a means of supporting system definition, system build, and load of a Target RTPS Set that has been loaded with a Platform load. System Build utilizes the CLCS Configuration Management Environment to

manage and select build input data.

2.4.3.1 The SDC shall provide the capability to build, and release, single and System Loads containing the Subsystem Loads for each supported RTPS Configuration in both operations and development environments.

2.4.3.2 The SDC shall provide the capability to build Subsystem Loads for each supported RTPS Configuration.

2.4.3.3 The SDC shall provide the capability to build and maintain Platform Loads consisting of COTS Operating Systems and COTS tools which are required to support a Subsystem Load.

2.4.3.4 The SDC shall provide a means of defining which Platform Loads are required for a System Build.

2.4.4 CLCS CONFIGURATION MANAGEMENT ENVIRONMENT REQUIREMENTS

The CLCS must provide the capability to develop and manage System Software, Application Software, and other strategic CLCS products for use in the RTPS and SDC. This capability must adequately control software throughout its development life cycle including, but not limited to, version and release management. This process, commonly referred to as Configuration Management (CM), must be capable of handling and storing all of the products needed to define and build the CLCS.

2.4.4.1 The SDC shall provide the capability for storing and archiving multiple versions of any file in a permanent repository (CM Repository).

2.4.4.2 The SDC shall provide a CM Repository capable of promoting and drawing down Configuration Managed files.

2.4.4.3 The SDC shall provide the capability to manage all CLCS Application Software products.

2.4.4.4 The SDC shall provide the capability to manage all CLCS System Software products.

2.4.4.5 The SDC shall provide the capability to manage all strategic office products (e.g., schedules, programmatic documents, set drawings).

2.4.4.6 The SDC shall provide the capability to manage Regression Test Products and Regression Test Results.

2.4.4.7 The SDC CM System shall provide reports on.

1. Files contained in various libraries.
2. Release documentation (e.g., PR, CR, Modules in release, version numbers, etc.).

2.4.4.8 The SDC shall record the all activities occurring in the CM system.

2.4.5 RECORDING REQUIREMENTS

This section contains requirements for recording of data sent to the SDC for recording from RTPS Test Sets. See Section 2.2.10 for requirements for data to be recorded by the RTPS. The CLCS will combine the functions currently performed by the Record and Playback System (RPS), Launch Data Bus Monitor (LDBM), Test Data Record and Retrieval (TDRR), and Processed Data Recorder (PDR) Subsystems into the SDC.

2.4.5.1 The SDC shall record data for all RTPS Test Sets.

2.4.5.2 The SDC shall record all data sent by any RTPS Test Set for recording..

2.4.5.3 The SDC shall provide the capability to record and analyze analog signals for SSME, PCM Downlink, PCM Uplink, and FM data.

2.4.5.4 The SDC shall provide the capability to record and analyze LDB and GSE bus data.

2.4.5.5 The SDC shall provide the capability to record all RTPS network communication

2.4.5.6 The SDC shall provide the capability to record and catalog RTPS processd data.

2.4.5.7 The SDC shall provide the capability to record, catalog, and index RTPS measurement and command data

2.4.5.8 The SDC shall provide local recording that can be transferred to the SDC.

2.4.6 RETRIEVING REQUIREMENTS

2.4.6.1 The SDC shall provide the capability to playback analog data.

2.4.6.2 The SDC shall provide the capability to retrieve recorded Measurement FD data in raw and formatted formats.

2.4.6.3 The SDC shall provide a set of programs to retrieve each different kind of data sent from a RTPS set in raw and formatted formats..

2.4.6.4 The SDC shall provide the capability to retrieve LDB and GSE data in raw and formatted formats.

2.4.6.5 The SDC shall provide the capability to retrieve, correlate, index, analyze, and format processed data.

2.4.6.6 The SDC shall provide a set of programs to aid in data reduction and analysis.

2.4.6.7 The SDC shall provide a capability to export data to users.

2.4.7 ARCHIVING REQUIREMENTS

2.4.7.1 The SDC shall provide online storage for raw data for all current flows.

2.4.7.2 The SDC shall provide online storage for process, measurement, and command data for 3 flows for each Orbiter.

2.4.7.3 The SDC shall provide online storage for command and measurement data for all terminal counts, engine hot firings and special tests.

2.4.7.4 The SDC shall provide off-line storage for all recorded data.

2.4.7.5 The SDC shall provide the capability to restore off-line data.

2.5 SIMULATION SYSTEM REQUIREMENTS

The Simulation System is the portion of the CLCS that provides support for the testing and validation of CLCS equipment; checkout and validation of procedures used in Shuttle ground testing and launch operations; training of CLCS console operators; and launch team training. The Simulation System supports the creation, modification, test, maintenance, and operation of mathematical models of Shuttle and GSE systems which simulate the ground equipment, Orbiter functions and computers, the ET, SRBs, and payload protocols.

2.5.1 SIMULATION SYSTEM

2.5.1.1 The Simulation System shall support the edit, compilation, and build of math models and associated model control procedures (MCPs).

2.5.1.2 The Simulation System shall support, the execution, testing, and checkout of models and MCPs.

2.5.1.3 The Simulation System shall support execution and interfacing models to the CLCS, in the real-time mode of operation to provide:

1. Testing and validation of CLCS User Application Software
2. Checkout and validation of test procedures (i.e., both manual and automated)
3. Launch team training
4. CLCS equipment check-out

2.5.1.4 The Simulation System shall support execution and interfacing models to the CLCS, in the non-real-time mode of operation to provide:

1. Development and debug of CLCS User Application Software
2. Development and debug of test procedures (i.e., both manual and automated)
3. Development and debug of CLCS System Application Software
4. Launch team member training

2.5.2 SIMULATION CONNECTIVITY

The Simulation System must support both integrated and non-integrated real-time testing, and non-real-time development and from office areas.

2.5.2.1 The Simulation System shall provide data link compatible real-time simulation capability to CLCS Gateway for all KSC RTPS Sets.

2.5.2.2 The Simulation System shall provide Gateway RTCN compatible real-time simulation capability interfacing with DDP and CCP Subsystems directly via a Simulation Gateway without the use of other front end Gateways for all KSC RTPS Sets.

2.5.2.3 The Simulation System shall provide network access to external non-real-time simulation capability to office area Application Test-bed Environments.

2.5.2.4 The Simulation System shall provide internal non-real-time simulation capability within office area Application Test-bed Environments.

3. PROBLEM BLUE BOOK REQUIREMENTS

3.1 REQUIREMENTS DRIVING COST

Advisory Systems	[2.3.17.60] CLCS will provide access to expert systems such as KATE, PSA, DLES, and IAPU from the business and information position.
CCS Set	Many CCS Requirements should be moved to the Launch Control Center Set.
Generic Console	[2.3.5.7] Hardwire safing will be implemented in a manner which allows the consoles to remain 'generic'.
Mini-cameras	[2.3.17.21] Mini-cameras are not required for early CLCS, but should be provided in later releases to allow video-teleconferencing.
Operational TV	[Various] CLCS requirements to integrate OTV into the CLCS.

3.2 REMOVED REQUIREMENTS

This section contains a list of significant requirements that were removed from the Blue Book requirements by the SLS Design and User Liaison Team. The requirements number from the Blue Book is preserved for ease of identification and enclosed in brackets []. Requirements in the Blue Book that were merged with other similar requirements are not listed here. The list contains only those requirements that were likely to be issues or those that needed extra visibility to the user community. In each case a short rationale statement is included to indicate why the requirement was removed.

[2.3.5.5] Provide additional LO₂/LH₂ safing to be able to drain the ET via hardware

Rationale: This requirement requires changes to the Orbiter. It can not be performed by CLCS alone. The requirement should be forwarded to the Orbiter Upgrade Project.

[2.3.11.6] Limits should be given names and a facility to predefine some of them and have them placed in the data bank should be available.

Rationale: Setting limits in the data bank for CCMS system has not proven to be a beneficial capability. The labor and time necessary to change data in the data bank and then edit or rebuild a TCID is prohibitive. A simplified approach is to create an application that sets the limits for a given set of measurements at the time that the measurements achieve compatible values (e.g., after a power supply has been powered up and stabilized it is appropriate to set the limits you wish to monitor and start monitoring them).

[2.3.17.10] PFPs will be provided at each command and control position.

[2.3.17.11] The PFP will be logically associated with the application running in the active window of the command and control CRT. This will be true even if the keyboard is switched to the business and information CRT at the position.

[2.3.17.12] The PFP will provide push-buttons to select functions.

[2.3.17.13] The PFP need not display currently active application names, but another means (task bar, etc.) will be provided to encompass this functionality.

Rationale: All four of the PFP requirements were removed because the requirements for PFPs at Console Positions are being questioned by the Ops Concept team.

Appendix A. — GLOSSARY

Active — A term used to describe one of the subsystem computers in an Active/Standby pair that is currently performing its intended function.

Application — An application is a computer software program, or set of programs, written to perform a specific task (e.g., MS Word, MS Power Point, CCMS Ground Launch Sequencer). There are two different categories of applications in CLCS — Systems Applications and User Applications.

Application Software - The CLCS software used to monitor and control a specific set of end item systems. It consists of executable software that controls and monitors end items, and tables that define the interface to end item systems.

Application Services - System Software that is used to access the RTPS services required for User Application execution. Optionally, it may also be used by System Applications.

Backup — A subsystem that can be used as a replacement for one of the pair of Active/Standby subsystem computers in the event of a failure. Manual activity is required to bring the backup subsystem online (i.e., the backup system is not maintained in a “hot” standby role).

Business and Information Network — The Business and Information Network is a network of communications paths, computers, and computer programs that provide access to information that is external to the CLCS.

Bypass Command — A command which bypasses the End Item Manager.

Calibration - Calibration is the process of converting the digital representation of an analog measurement that has been acquired from a sensor to a floating point value that represents the calibrated engineering units of the measured quantity (e.g., pounds of pressure per square inch, temperature, speed, etc.). Sensors convert the measured quantities to an electrical voltage (an analog signal) which is subsequently converted to a digital quantity by an analog to digital converter (ADC). Sensors may introduce non-linearities into the measured quantities due to the physics of the measuring device. If the voltage output of the sensor has a linear relationship with the pressure measured by the sensor, engineering units can be calculated by the linear equation.

Measurement Value = $m * \text{voltage} + b$, (where m is the slope of the line and b is the voltage value when the pressure is equal to zero.)

For non-linear signals a polynomial is required to convert the voltage value to the equivalent pressure value. An n^{th} order polynomial, of the form below, is used to make this conversion:

Measurement Value = $a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x^1 + a_0$, (where x represents the sensor voltage)

Calibrated Measurement Data — Analog data which has been converted to engineering units and calibrated by applying the calibration coefficients.

Cargo Integrated Test Equipment Set (CITE) — The Cargo Integrated Test Equipment Sets are located in the Space Station Processing Facility (SSPF) and Vertical Processing Facility (VPF) and are used to integrate and test payloads prior to them being loaded into the Orbiter.

CCMS Set — The set of equipment used to control and monitor end items using the CCMS. See table A-1 for a list of CCMS Sets.

CDBFR Counts — CDBFR counts are count values resident in the CDBFR. These counts are left justified within the CDBFR word. All CDBFR counts are assumed to be linear, bipolar, 2's complement, big-endian integer values. CDBFR count values can be up to 16-bits long. This terminology is new and is introduced to clarify the distinction between right justified processed counts and left justified CDBFR counts.

CDBFR Length — The CDBFR length of a measurement is the number of CDBFR bits required to represent the measurement in CDBFR counts. For example, the CDBFR length of an 8-bit unipolar GSE measurement is 9; 1 sign bit plus the 8 unipolar magnitude bits (remember that CDBFR counts are always assumed to be bipolar, thus a sign bit must be added to unipolar measurements by the FEP). The CDBFR length of a 10 bit bipolar PCM measurement is 10; the sign is already part of the raw data and does not have to be added. CDBFR lengths range from 2 to 32 bits. Since the CCMS CDBFR uses 16-bit words, any measurement with a CDBFR length > 16 requires two CDBFR locations

CDBFR Size — The CDBFR size of a measurement is the total number of CDBFR bits being used to hold the measurement. In CCMS, single word analogs (AM) reside in a single CDBFR location, thus the CDBFR size is 16. Multi-word analogs (AMDP) reside in two CDBFR locations, thus the CDBFR size is 32.

Calibrated Engineering Units (CEU) — See Calibrated Measurement Data.

Checkout and Launch Control System (CLCS) — The Checkout and Launch Control System is the replacement for LPS and is composed of a Real-Time Processing System, Shuttle Data Center, Simulation System, and a Business and Information Network.

CLCS Configurations - Alternate, scaleable, run-time equivalent RTPS configurations produced by a System Build.

1. Full Configuration - Supports full real-time RTPS performance and redundancy management. It contains no combined Subsystems.
2. Limited Configuration - Supports limited real-time RTPS performance and limited redundancy management. It contains DDP/CCP combined Subsystems.
3. Minimal Configuration - Does not support real-time RTPS performance or redundancy management. It contains DDP/CCP/HCI combined Subsystems. A minimal configuration may include internal modeling or a Simulation Gateway.

CLCS Environments - Each CLCS Environment has targeted purposes and supported configurations:

1. Application Test-bed Environment - Supports single user development and debug of all User and most System Applications. It normally uses a desktop Minimal Configuration and may employ an internal or external model.
2. Integrated Development Environment - Supports multi-user, fully integrated, debug, test and validation. It can be used for limited team training.
3. Office Environment - Supports monitor only User Display execution from the office areas. It permits the same User Displays used in the other environments to be used with conventional office remote PC hardware.
4. Operational Environment - Supports operational use of CLCS Sets. It is used to monitor and control end item hardware. It can be used for team training.
5. Satellite Development Environment - Supports multi-user development, debug and limited integration testing of System and Application Software

Command Panel — Command Panels are Input/Output (I/O) devices that provide information to and receive manual inputs from Console Position users.

Common Data Buffer (CDBFR) — A shared memory that contains the current status of all measurement data and subsystems in a CCMS set. The CDBFR also provides allows transmission of all messages in a CCMS set.

Common Equipment Area (CEA)— The Common Equipment Area is the back room of the OCRs and MFR and contains the Control Groups (CCP, DDP), Gateway Groups, and network equipment for the Launch Control Center Set.

Complex Control Set (CCS) — The Complex Control Set is located in the LCC at the Kennedy Space Center. It is used to monitor and control facilities equipment at KSC.

Computer Software Configuration Item (CSCI) — An aggregation of software and documentation that satisfies an end use function and is designated for separate configuration management by the acquirer. CSCIs are selected based on tradeoffs among software function, size, host or target computers, developer, support concept, plans for reuse, criticality, interface considerations, need to be separately documented and controlled, and other factors.

Configuration Item (CI) —An aggregation of hardware, software, or both that satisfies an end use function and is designated for separate configuration management by the acquirer.

Console — This term is used exclusively to describe the three-bay housing in the CCMS LPS system.

Console Back Row — This term is used exclusively to describe the CCMS set of MODCOMP computers, tables and PCGOAL workstations that reside behind the Consoles in the CCMS LPS system.

Console Position — The CLCS Console Position is a generic term used to refer to all the necessary workstations, hardware, peripherals and connectivity required (e.g., OIS-D, OTV, Safing, Applications Software Access, Business Systems Access, etc.) to support any the human interface to the RTPS.

Console Support Module — A CLCS Console Support Module provides the necessary table space, hardware and connectivity to allow additional users to comfortably support operations taking place at a CLCS Console Position.

Constraint Management — The capability to monitor Measurement FDs for a predetermined condition and notify personnel operating the Test Set and other software applications executing within the Test Set that the monitored data no longer meets the predetermined condition.

Control Group — A physical set of hardware consisting of Data Distribution Processors and Command Control Processors connected together along with the associated Real-Time Critical Network and Display and Control Network equipment.

Controlling — A term used to describe a software process that is currently actively monitoring and managing a set of hardware or software resources. The process normally has a second copy of itself that is executing in a separate CPU and monitoring the activities of the controlling process. On command, this second copy will assume control of the resources

Converted Counts — Converted counts are raw counts that have undergone subtype-dependent processing in the FEP to isolate and position count data within a data word. Examples of subtypes that require processing are Binary Coded Decimal (BCD), TACAN Bearing (TAB), BIT String Magnitude (ASM), and Halfword Overflow Signed (AOS). Other than the fact that converted counts have had some “conversion processing” performed, these counts are similar to raw counts, i.e., they are right justified, bipolar, 2’s complement, big-endian integer values. This terminology is new and is introduced to clarify the distinction between right justified raw counts and right justified processed counts.

Data Fusion — Data fusion is the process of combining measurement data and other CLCS system parameters into a higher level of information. The process for combining data may include algebraic and logical manipulation of data and conditional testing of system parameters or intermediate calculated values. The combined or “fused” data is a CLCS function designator.

Data Health — The combination of gateway status for each item of data and user defined health for the data item. Data health contains both health warning and failure information.

Data Status — The portion of data health that relates strictly to the status of the data item as determined by the gateway (e.g., a measurement who’s status indicates it isn’t being updated because it isn’t in the current PCM format).

Delivery – An incremental deployment of CLCS development consisting of facilities preparation, hardware, and software.

Delivery Theme – The primary driving force for determining the capabilities to be deployed in a CLCS delivery.

Derived Measurement — A Derived Measurement is one whose value is created within the RTPS.

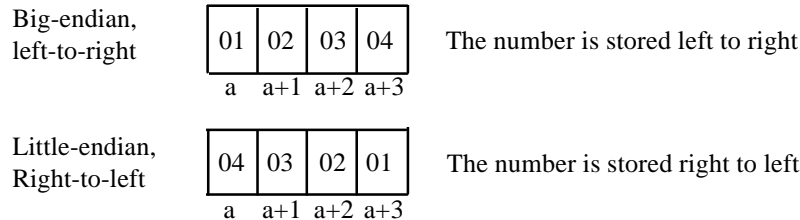
Direct Command — A command to the End Item Manager to disable closed loop control of a function and allow issuance of a command to the end item itself.

Display Attribute – Information relating to a piece of data being displayed (e.g., color).

Display Synchronous Rate (DSR) — The rate at which data is distributed for display.

Dryden Flight Research Center (DFRC) Set — The Dryden Flight Research Center Set, located at Edwards, California, is used to monitor and control the Orbiter during landing operations.

Endian Architecture — When several bytes are required to store data, computers differ in which byte of storage they consider to be the “first”. In “right-to-left” or “little-endian” architecture, which include the Intel 80x86 and Pentium microprocessor, the address of a 32-bit integer is also the address of the low-order byte of the integer. In “left-to-right” or “big-endian” architectures, which include the Motorola 680x0 microprocessor family, the address of a 32-bit integer is the address of the high-order byte of the integer. Consider the number 1234 that is stored in addresses a through a+3:



End Item — The set of actuators, transducers, software and equipment that are controlled by CLCS. This term is used to indicate both the lowest level of end item (e.g., a valve) and the collection of end items that constitute a larger end item (e.g., APU, Orbiter, Payload, Facilities Equipment).

End Item Manager — The software used to implement closed loop control of End Items within CLCS.

Engineering Units — Engineering units are the representation of the measurement in the units understood by the user (e.g., volts, PSI, feet per second, etc.). Floating point numbers are used to represent engineering units. The engineering unit range depends on the type of hardware transducer.

Flight Vehicle — The term used to refer to the Orbiter, External Tank and Solid Rocket Boosters; this term does not also refer to the Payload.

Flow Zone — A collection of console positions configured to support a particular test. Within an OCR, one or more flow zones can exist and will fluctuate according to the test configurations.

Focal Thread — Each CLCS delivery will have one to two focal threads that are used to integrate work from multiple system threads. Taken together, the focal threads provide the delivery theme capability and normally focus on the user.

Forward Link Mode — A mode in which the RTPS PCM Uplink can operate, in which data is transmitted at 128 Kbs to the Orbiter Communications Interface Equipment (CIE) via the ground Communications and Tracking (C&T) station.

Fractional Counts — Fractional counts are a floating point “interpretation” of CDBFR counts that assumes an implied binary point exists to the right of the sign bit. Mathematically, then, fractional counts range from -0.5 to +0.5. CCMS console software converts CDBFR counts to fractional counts prior to scaling.

Function Designator (FD) — Data processed by the CLCS which has been acquired from the End Item under test, calculated by Data Fusion, determined by System Software, derived by a user test application or the last commanded value of an output command. Measurement FDs consist of the following specific FDs:

1. End Item FDs
2. Data Fusion FDs
3. System Status FDs
4. Pseudo FDs
5. Commanded Status FDs

Function Designator Data — The set of data relating to a function designator. The data consists of FD Value (i.e., Converted Counts, Calibrated Engineering Units), FD Health, FD Time of occurrence, and Display Attributes.

Gateway Group — The collection of Gateways which are physically linked to a particular physical area (e.g., Pad A, OPF 1, etc.).

Hardware Configuration Item (HWCI) — An aggregation of hardware that satisfies an end use function and is designated for separate configuration management by the acquirer.

Hot Standby — An on-line resource ready to be configured to serve as a replacement for another resource.

Hypergol Maintenance Facility (HMF) Set — The Hypergol Maintenance Facility Set is located in the industrial area at the Kennedy Space Center. The HMF Set is used to monitor and control Hypergolic equipment from the Orbiter that is being reconditioned and refurbished for reuse.

Intrusive — Any process or event which will significantly alter the normal configuration or operation of an on-line resource.

Kennedy Avionics Test System (KATS) Set — The Kennedy Avionics Test System Set is located in the VAB at the Kennedy Space Center and is used to provide limited avionics test and simulation capability without utilizing the larger Shuttle Avionics and Integration Lab at the Johnson Space Center. KATS also supports procedure development and, in a limited capacity, pre-installation flight element LRU checkout.

Launch Control Center (LCC) Set — The Launch Control Center Set consists of all of the RTPS equipment located in the OCRs, CEA, MFR of the LCC at the Kennedy Space Center. This equipment may be configured into subsets or supersets to accommodate tests requiring varying RTPS resources to support appropriate End Items.

Launch Data Bus Monitor (LDBM) — A collection of equipment used to record all message traffic on the LDB and GSE data busses.

Linearization — Signal non-linearities are introduced into analog measurements by signal conditioners and transducer non-linearities. The CCMS system assumes that the analog data, which is stored and processed from the CDBFR, exhibits a linear relationship between the signal (in counts) as recorded in the CDBFR and the actual signal fluctuation as measured by the transducer. A method of accounting for this non-linearity was implemented in LPS. The capability was provided to associate line segment approximations of the calibration data curve with an analog measurement. The linearization curve is approximated by the use of one or four line segments. Each line segment has a K1 (slope) value and a K2 (Y-intercept) value which constitutes the standard equation for a line.

Local Operations — Local Operations are those that are performed in the vicinity of the actual hardware.

Logged Data — Data that is sent to the recording system to be recorded.

Mini-Peripheral Test (MPT) Set — A KSC CCMS test set used to maintain CCMS hot spare equipment.

Multi-Function Room (MFR) — The Multi-Function Room is one of the rooms which was formerly a KSC Launch Control Center (LCC) Firing Room. The MFR contains the Flow Zone and Shared I/O Area used for Flight Vehicle, Payload and GSE Processing.

Non-Controlling — A term used to describe a software process that is designated to replace the Controlling process in the event of a failure. The Non-Controlling process monitors the system configuration but does not actively manage the configuration unless the Controlling process fails.

Non-Intrusive — Any process or event which will not significantly alter the normal configuration or operation of an on-line resource.

Non-Operational — The state of a resource known to not be ready to support an activity.

Off-line — A term used to signify a physical resource is neither ready to participate nor is participating within a Set.

On-line — A term used to signify a physical resource is ready to participate or is actively participating within a Set.

Operational — The state of a configured, initialized resource that is ready to support.

Operational Readiness Test (ORT) — A set of software used to verify that a subsystem's hardware and software is ready to support testing.

Operations Control Room (OCR) — Operations Control Rooms are rooms which were formerly KSC Launch Control Center (LCC) Firing Rooms. The OCR contains the Flow Zone and Shared I/O Area used for Flight Vehicle, Payload and GSE processing.

Override — An override is a keyboard command to Prerequisite Control Logic (PCL) requiring PCL to issue a command that has failed its prerequisite checks.

Platform Load — The combination of the tailored Operating System (OS) and COTS software which may be loaded onto a CLCS Subsystem HW.

Prerequisite Sequence — A prerequisite sequence may be defined for every end item command. When a command with a prerequisite sequence is issued from the keyboard or an application program the prerequisite sequence is executed. If the prerequisites are passed, the command is issued; otherwise, it is rejected. A rejected command may be overridden by the operator.

Processed Counts — In CCMS, processed counts are raw counts that have undergone subtype-dependent processing in the FEP (i.e., converted counts). Processed counts have been linearized by the FEP using line

segment data from its' tables, if the measurement requires it, and are bipolar, 2's complement, big-endian integer values. The CCMS usage of the term may imply right-justified counts or left-justified counts (see CDBFR counts).

Pseudo Function Designator — A pseudo FD is a FD that is updated by applications within the RTPS. Pseudo FDs have many of the characteristics of measurement FDs (e.g., they are defined in the CLCS Data Bank, have On-line Data Bank entries, may be used by Data Fusion, etc.).

Raw Counts — Raw counts are the count values as received from the hardware. These counts are right justified. Raw counts are represented by an Integer value whose range depends on the measurement length. The normal count range for an 8-bit unipolar GSE measurement is +3 to +253. A 10 bit PCM bipolar measurement ranges from -512 to +511.

Real-Time Processing System (RTPS) — The Real-Time Processing System consists of Gateway Groups, Control Groups and Flow Zones. This equipment performs the real-time processing for CLCS.

Reduced Capability Mode — A mode of the CLCS in which all normal functionality defined for the Test Set is not present. This mode may be entered in a number of ways.

Redundant Pair — A term used to represent the association of an Active/Standby resource.

Responsible System — The set of users and applications responsible for controlling and monitoring a given end item system.

RTPS Set — The collection of equipment in a physical facility that is interconnected and dedicated to performing a major function or task (e.g., CITE is used for Payload Integration and Checkout). The equipment contained in a RTPS Set consists of the equipment contained in Flow Zones, Control Groups, Gateway Groups, and associated Networks (RTCN, DCN, & RON). Table A-1 lists the CCMS and RTPS Sets.

Set Name	CCMS Set	RTPS Set
Launch Control Center (LCC) Set	N	Y
Cargo Integrated Test Equipment (CITE) Set	Y	Y
Complex Control (CCS) Set	Y	TBD
Firing Room Number 1	Y	N
Firing Room Number 2 (Multiple Sets)	Y	N
Firing Room Number 3	Y	N
Hypergol Maintenance Facility (HMF) Set	Y	Y
Dryden Flight Research Center (DFRC) Set	Y	Y
Kennedy Avionics Test System (KATS) Set	N	TBD
Mini-Peripheral Test (MPT) Set	Y	N
Processing Control Center	Y	N
Shuttle Avionics Integration Lab (SAIL) Set	Y	Y
Development Sets		
Integrated Development Environment (IDE)	N	Y
Set	N	Y
Satellite Development Environment (SDE) Set		

Table A-1 - CCMS and RTPS Sets

Safing System — A collection of hardware and software that provides a means, with minimal or no RTPS availability, to place a facility or Flight Vehicle into a known and safe state.

Scaleable Architecture — The RTPS Scaleable Architecture provides the capability to build the Minimal, Limited, and Full RTPS run time equivalent configurations.

Shareable Library — A collection of object code which may be linked with other object code at run time

Shared I/O Area — The area in an Operations Control Room (OCR), Multi-Function Room (MFR), or Specialized Processing Site containing printers, plotters, and other devices that are shared by multiple users in the Test Set.

Set Point — The value of a function in a closed loop application that the End Item Manager is maintaining.

Shuttle Avionics Integration Lab (SAIL) Set — The Shuttle Avionics Integration Lab Set is located at the Johnson Space Center. The SAIL Set is used to verify CLCS Software in the avionics integration environment at SAIL.

Shuttle Data Center (SDC) — The collection of hardware and software that provides the capability to build system and test software and monitor data via Constraint Management.

Shuttle Data Stream (SDS) — The Shuttle Data Stream is used to provide data to users outside of the controlled environment for the purpose of monitoring operations. This data can be certified or uncertified based on location, purpose of use and configuration control. There is a CLCS SDS as well as a CCMS SDS.

Simulation System — The portion of the CLCS that provides support for the testing and validation of CLCS equipment; checkout and validation of procedures used in ground testing and launch operations; training of CLCS console operators; and launch team training

Software Release — A collection of files, together with their version number, that make up a software build.

Specialized Processing Site — An RTPS set used in a location other than the KSC LCC to perform checkout, control and monitoring of local end items.

Standby — A term used to identify which one of the computers in an Active/Standby pair is designated to replace the Active in the event of a failure. The Standby subsystem is maintained in a “hot” standby state (i.e., it can immediately assume the role of the failed Active).

Station Set — A Station Set is a facility and all of its equipment (e.g., OV 104, Pad A, High Bay 1, OPF 1).

Subsystem — The collection of hardware and software that is combined to perform a specific set of functions (e.g. GSE Gateway, CCP, DDP).

Subsystem Hardware — The Hardware Configuration Items (HWCI) that are required to perform the functions of a subsystem.

Subsystem Load — The Computer Software Configuration Items (CSCI) that are combined to perform the functions of a subsystem.

System Application — The System Software that implements the subsystem functionality of an RTPS System. System Applications are normally transient applications that are either executed when a subsystem enters an operational mode or when a specific service performed by them is requested. System Applications utilize either System Services or Application Services to assist in accomplishing their task.

System Build — The build process required to create the System Software load of RTPS subsystems (i.e. Subsystem Loads). The build product is a System Configuration ID (SCID) which supports all CLCS Configurations. It also identifies the Operating System Load versions required for each Subsystem

System Configuration Identifier (SCID) — System Configuration Identifier is a CLCS term used in two different instances:

1. The label used to identify the System Build products constructed for a CLCS release
2. The collection of System Build products used in the RTPS subsystem computers.

System Services — The System Software that supplies features necessary to implement RTPS subsystem. It provides a portable layer for vendor specific COTS operating systems and COTS product services. It is used by System Applications and Applications Services.

System Software — The CLCS software that provides the development, build, and execution framework for operating a CLCS set and executing Application Software. System Software is incapable of monitoring or controlling end item systems without the use of Application Software

System Software Build — The process of creating software that is ready for loading into the RTPS subsystem computing equipment.

System Synchronous Rate (SSR) — DSR and user and system applications in the real time portion of the system.

System Tables - System Software that is non-executable and is loaded into various subsystems within the RTPS in order to permit proper execution of System Software for operation of an RTPS set.

System Thread — The set of software in a CLCS delivery that provides a system-wide capability.

Test Article — Test Article is a little used term to specifically define a system and may be composed of multiple End Items (e.g., the APU System is a Test Article).

Test Build — The build process required to create the Application Software (User Applications and User Tables), load files required to support RTPS monitoring and control of end item systems. The build product is a Test Configuration ID (TCID) which supports one or more System Builds.

Test Configuration Identifier (TCID) — Test Configuration Identifier is a CLCS term used in two different instances:

1. The label used to identify the Test Build products constructed for a CLCS release
2. The collection of Test Build products that define the set of end items to be tested.

Test Set — A group of CLCS RTPS Subsystems and networks configured for a specific test. Typically a Test Set will include one or more Gateways within a Gateway Group, some portion of an RTCN's bandwidth, one or more DDPs and CCPs within one or more Control Groups, some portion of a DCN's bandwidth, and one or more Console Positions. This entire set of equipment would constitute a Test Set. For example, a Launch configured Test Set would include all the Gateways in that Pad's Gateway Group, RTCN, two Control Groups with several DDPs and a larger number of CCPs utilized, the DCN within that OCR, and a Flow Zone consisting of all the Console Equipment in that OCR.

Thread — See System Thread.

Time Homogeneous Data Set (THDS) — A group of measurement data or measurements which must be viewed and updated as a group.

User — The term user is used in this document to mean a human being that is using CLCS equipment (hardware and software) to perform a given task. There are many users of the CLCS system

1. Operations user — one who uses the CLCS to process and or control end items.
2. Build user — one who uses the CLCS to build, system or test, software products to be used in the CLCS.
3. O&M user — one who operates and maintains the CLCS equipment.

User Applications — Application Software written by users. Most user applications are developed to run on the RTPS and are used to control and monitor End Items..

User Application Registration - The method used to dynamically connect User Applications to other User Applications and Function Designators. It ensures that all required services exist and are used properly, performs registration at User Application program startup to ensure compatibility and immediate availability, verifies external references. Additionally, it is used during the Test Build phase to verify and construct tables for running subsequent Inverted Index queries to assess impacts of future User Application changes.

User Tables - Application Software that is non-executable and is loaded into various subsystems within the RTPS in order to permit proper execution of User Applications and to define the interface with end item Function Designators.

Workstation — A desktop computer. In a CLCS OCR a workstation is a desktop computer utilized in a CLCS Console Position or Console Support Module. There are two kinds of workstations in CLCS:

1. Workstations for executing CLCS applications and viewing CLCS displays. This workstation could have more than one monitor.
2. Workstations for business systems connectivity to access on-line documentation and historical log books, generate deviation paperwork (e.g., IPRs, PRACA, Deviation Records) and to provide connectivity to center-wide and world-wide information.

Appendix B. — DATA TYPES

This section contains a definition of LPS Data Types and Subtypes. It also contains a matrix describing the LPS links and the allowable types and subtypes on each link.

TYPES

The assignment of TYPE to an FD indicates to CLCS the basic data configuration and type of processing to be performed. Descriptions of the various Types are as follows:

Analog Measurement (AM)

- Represents an analog signal input to CLCS
- May be unipolar or bipolar
- 1 to 16 bits in length

Analog Measurement Serial Input/Output (AMS)

- Represents an analog signal input to CLCS from an onboard serial input device
- May be unipolar or bipolar
- 2 to 16 bits in length
- Accessible via the Launch Data Bus (LDB)

Analog Stimulus (AS)

- Represents an analog signal output from CLCS
- May be unipolar or bipolar
- 2 to 16 bits in length

Analog Stimulus Serial I/O (ASS)

- Represents an analog signal output from CLCS to an onboard serial output device
- May be unipolar or bipolar
- 2 to 16 bits in length
- Accessible via the LDB

Discrete Measurement (DM)

- Represents a discrete event input to CLCS
- 1 bit in length

Discrete Measurement Serial I/O (DMS)

- Represents a discrete event input to CLCS from an onboard serial input device
- 1 bit in length
- Accessible via the LDB

Digital Pattern Measurement (DPM)

- Represents a numeric quantity input to CLCS
- 2 to 16 bits in length

Digital Pattern Measurement Serial I/O (DPMS)

- Represents a numeric quantity input to CLCS from an onboard serial input device
- 2 to 16 bits in length
- Accessible via the LDB

Digital Pattern Stimulus (DPS)

- Represents a numeric quantity output from CLCS

- 2 to 16 bits in length

Digital Pattern Stimulus Serial I/O (DPSS)

- Represents a numeric quantity input from CLCS to an onboard serial output device
- 2 to 16 bits in length
- accessible via the LDB

Digital Pattern Stimulus With Data (DPSD)

- Represents a digital pattern stimulus with a fixed data pattern to be sent from CLCS to an onboard device - may be one or two words of data, depending on BTU class
- Accessible via the LDB and Uplink

Double Precision Analog (AMDP)

- Represents an analog signal input to CLCS
- 17 to 32 bits in length

Discrete Stimulus (DS)

- Represents a discrete output from CLCS - 1 bit in length

Discrete Stimulus Serial I/O (DSS)

- Represents a discrete event output from CLCS to an onboard serial output device
- 1 bit in length
- Accessible via the LDB

Floating Point (FP)

- Represents an analog signal input to CLCS
- May be either half, single, extended, or double precision with corresponding lengths of 16, 32, 48, and 64 bits
- Accessible via EIU1, EIU2, EIU3, GPCLNK and LDB (GMM)

Multiword Digital Pattern (MWDP)

- Represents a numeric quantity
- 17 to 64 bits in length
- Accessible via EIU1, EIU2, EIU3, and GPCLNK
- Generated at KSC (not in JSC MMDB)

SUBTYPES

The assignment of SUBTYPE to a FD provides additional details of the data configuration for analog measurements and stimuli, floating point measurements and digital pattern stimuli with data. For digital pattern types, subtype information allows the assignment of the numerical base for displaying and recording the Function Designator. Description of the various subtypes are as follows:

Analog Measurement and Stimuli Subtypes

Analog Bipolar (AB)

- The left most bit is the sign bit
- The next bit is the MSB
- The right bit is the LSB
- The magnitude bits describe a decimal integer in binary
- If the sign bit is negative (1) then the magnitude is in two's compliment form

Analog Unipolar (AU)

- For KSC GSE the left most bit is the MSB

- For LDB and PCM the second bit is the MSB
- The magnitude bits describe a decimal integer in binary

Binary Coded Decimal (BCD)

- The start bit is the MSB
- The magnitude bits are a four bit BCD code describing a decimal number starting with the LSB

Bit String Magnitude (ASM)

- The left most bit is the sign bit
- The second bit is the MSB
- The magnitude bits describe a decimal number in binary

Halfword Overflow Signed (AOS)

- The left most bit is the sign bit
- The second bit is the overflow bit
1 = overflow 0 = No overflow
- The third bit is the MSB
- The magnitude bits describe a decimal number in binary

Halfword Unsigned (AHU)

- The left most bit is the MSB
- The magnitude bits describe a decimal number in binary

TACAN Bearing Word (TAB)

- MMDB BSE data type
- 2-15 bits in length
- Has a data range and units
- Originates from TAC card
- Card and channel location is zero
- The start bit is the MSB

Analog Measurement Filter (AMF)

- Has a length of 1
- The Gateway will compute a 16 bit bipolar analog filtered value for ET OI point sensors
- Valid on all PCM links
- Has an associated AMF constant whose value is less than 1 and greater than zero; up to 6 digits to the right of the decimal point may be specified
- Significant change parameter is invalid for this subtype

Floating Point Subtypes

Only valid on the GPCLNK

Half Precision (HPL)

- Length is 16 bits
- In CCMS this subtype was treated by GOAL and the CCMS Command Processor as an SPL subtype

Single Precision (SPL)

- Length is 32 bits
- A floating point number consisting of an unsigned characteristic (or exponent) and a signed fraction; the quantity expressed by this number is the product of the fraction and the number 16 raised to the power of the exponent

where:

Bit 00 = Sign of Fraction
 = Positive
 = Negative

Bit 01-07 = Characteristic - A binary number with a range of 0 through 127. The exponent is derived by subtracting 64 from the characteristic. Therefore, the range of the exponent is -64 through +63.

Bit 08-31 = Fraction - A binary number less than 1 with the binary point to the left of the high order digit (between bit 7 and 8)

Extended Precision (EPL)

- Length is 48 bits
- In CCMS this subtype was treated by GOAL and the CCMS Command Processor as a DPL subtype

Double Precision (DPL)

- Length is 64 bits
- A floating point number consisting of an unsigned characteristic (or exponent) and a signed fraction; the quantity expressed by this number is the product of the fraction and the number 16 raised to the power of the component

Bit 00 = Sign of Fraction
 0 = Positive
 1 = Negative

Bit 01-07 = Characteristic - A binary number with a range of 0 through 127. The exponent is derived by subtracting 64 from the characteristic. Therefore, the range of the exponent is -64 through +63.

Bit 08-63 = Fraction - A binary number less than 1 with the binary point to the left of the high order digit (between bits 7 and 8)

Double Precision Analog Subtypes (Downlist Only)

Analog Bipolar (AB)

- The left most bit is the sign bit
- The second bit is the MSB
- The magnitude bits describe a decimal integer in binary

Analog Unipolar (AU)

- the left most bit is the MSB
- the magnitude bits describe a decimal integer in binary

TACAN Range Word (TAC)

- The length must be 18 bits
- The start bit is the MSB
- The magnitude bits are assumed to be a four bit code defining a decimal number starting with the LSB

Digital Pattern Subtypes

Digital pattern subtypes provide a means of specifying the numerical base for displaying and recording the FD values for digital patterns of 2-16 bits. Valid subtypes are as follows:

OCT - Octal Number

HEX - Hexadecimal Number
BCD - Binary Coded Decimal Number
BIN - Binary Number
DEC - Decimal Number

Discrete Subtypes

Valid Subtypes are as follows:

BD - Binary Discrete

Multiword Digital Pattern Subtypes

The Multiword digital pattern subtypes provide a means of specifying the numerical base for displaying and recording measurement values with data lengths between 17 and 64 bits. Valid subtypes are as follows:

BIN - Binary Number
OCT - Octal Number
DEC - Decimal Number
HEX - Hexadecimal

Digital Pattern Stimuli With Data (DPSD) Subtypes

The DPSD subtypes provide a means of specifying exact bit configurations for digital pattern commands. The valid subtypes for DPSD commands are ONE and TWO.

ONE

- only one 16 bit data word is required
- the bit configuration will be available in the WRD1 field of the CLCS Databank as an unsigned decimal integer

TWO

- two 16 bit data words are required
- the bit configurations will be available in the WRD1 and WRD2 fields of the CLCS Databank as unsigned decimal integers
- WRD1 and WRD2 apply to two hardware addresses for FD's with a BTU class of MDM or FLX

Bus Terminal Unit (BTU) Subtypes

The BTU subtypes provide a means of identifying specific PDI/PCR functions.

Valid subtype assignments for BTUC=PDI:

FPM - Fetch Pointer Memory
DC1 - Decom 1
DC2 - Decom 2
DC3 - Decom 3
DC4 - Decom 4
DRM - Data RAM
BSR - BITE Status Register
SMR - Switch Matrix

Valid subtype assignments for BTUC=PCM

PCM - Unassigned PCM
POI - PCMMU OI
P28 - PCMMU 128
P64 - PCMMU 64

NOTE: The subtype parameter is only valid for BTU with a BTU class of PDI or PCM.

VALID TYPES AND SUBTYPES FOR LINK AND TYPE

GATEWAY LINK TYPE	CITE GSE LINKS	LDB	UPLINK	PLDOI PLDPL EIU1-3 COMMON DOWNLINKS ET OILNK	FAC1	TMDB	SDBLK1-2
AM	AU	AU, AB, AHU, ASM, AOS, TAB, BCD		AMD, AMF, AU, AB, AHU, ASM, AOS, TAB, BCD	AB		AB, AU
AMDP				AU, AB, TAC**			
AMS, ASS		AU, AB, AHU, ASM, AOS, TAB, BCD					
AS	AU	AU, AB, AHU, ASM, AOS, TAB, BCD					
BTU		BSR, FPM, DC1, DC2, DC3, DC4, DRM, PCM, POI, P28, P64, SMR	BSR, FPM, DC1, DC2, DC3, DC4, DRM, PCM, POI, P28, P64, SMR				
DM	BD	BD		BD	BD	BD	BD
DMS, DSS		BD					
DPM	DEC, OCT, HEX, BIN, BCD	DEC, OCT, HEX, BIN, BCD		DEC, OCT, HEX, BIN, BCD			
DPMS, DPSS		DEC, OCT, HEX, BIN, BCD					
DPS	DEC, OCT, HEX, BIN, BCD	DEC, OCT, HEX, BIN, BCD	DEC, OCT, HEX, BIN, BCD				
DPSD		ONE, TWO	ONE, TWO				
DS	BD	BD	BD		BD	BD	BD
FP		*** SPL, DPL		**** SPL, DPL, HPL, EPL			
MWDP				BIN, OCT, DEC, HEX			

** Subtype of TAC not valid on 8-bit PCM links

*** Floating Point on LDB must have a BTU class of GMM

**** Floating Point not valid on the following 8-bit PCM Links: OILNK, ET, COMMON DOWNLINKS, PLDOI, PLDPL

Appendix C. — CCMS KEYBOARD

Command Portability Matrix

The table on the following pages list CCMS commands, OC tasks, Transients, and Programs. These commands and programs were compiled by searching the CCMS Design Documents and User's Guides for each. Following is a description of each column in the tables:

- **COMMAND DESCRIPTION** - A description of the command and the proposed syntax.
- **IMPL**
 - N/Y = Whether existing command should be implemented in RTPS
 - E = Equivalent functionality required
 - D = Duplicate functionality provided elsewhere
- **CP**
 - Rewrite as a Command Processor command
- **SV**
 - Rewrite as a System Viewer command
- **SA**
 - Rewrite as a System Application (See Glossary)
- **UA**
 - Rewrite as a User Application (See Glossary)

KEYBOARD COMMAND PORTABILITY MATRIX

COMMAND DESCRIPTION	IMPL	CP	SV	SA	UA
CCMS Installation (\$INST)	E			Y	
Load Operations (MCPRELD)	E			Y	
Test Operations Change (\$TOC)	N				
CCMS Load and Initialization (\$CLAI)	E			Y	
CCMS Configuration Update (UPDATE)	E			Y	
CCMS Termination (\$TERM)	E			Y	
Checkpoint Restart (GWCPR)	Y			Y	
Checkpoint Restart (User Application Interface)	N				
Application Procedure Control	Y	Y			
PCM Source Select (PCMS)	Y	Y			
Display Monitor (DMON)	Y	Y	Y		
Exception Monitor (A/I SX)	Y	Y	Y		
Status Hot Spares (S HS)	E	Y	Y		
Read GSE HIM Output Function Designator (R FD)	New	Y	Y		
Status Function Designator (S FD)	Y	Y	Y		
Status Inhibited FDs (SIFD) (GOAL can call SIFD)	Y		Y	Y	
Switch Scan (SWSCAN)	Y			Y	
System Status (SYST)	Y		Y	Y	
Act/Inh Data Acquisition (A/I DA)	Y	Y			
Act/Inh Data Processing (A/I PR)	Y	Y			
Act/Inh Command Issuance (A/I CM)	Y	Y			
Allow/Inh LDB/UPLK Requests (A/I CMD)	Y	Y			
Act/Inh SPA to issue LDB commands (A/I SP)	E	Y			
Act/Inh GOAL Exception Notification (A/I GX)	E	Y			
Act/Inh Control Logic Exception Notification (A/I CX)	E	Y			
Act/Inh CDS Logging (A/I CD)	N				
Act/Inh Linearization (A/I LI)	N				
Act/Inh HIM Polling Command (A/I HI)	Y	Y			
Act/Inh HIM Testing Command (A/I HT)	Y	Y			
Act/Inh SMW Routing (A/I SM)	N				
Allow/Inhibit Redundant Switch (A/I RS)	Y	Y			
Act/Inh Inhibit Serial Dump Processing (A/I SD)	Y	Y			
Act/Inh EMON Alarm Notification (A/I EN)	Y	Y			
Act/Inh Polling On An RTU (A/I RT)	Y	Y			
Allow/Inh Keybd Perform Of Utilities (A/I KU)	Y	Y			

COMMAND DESCRIPTION	IMPL	CP	SV	SA	UA
Allow/Inh Remote S/W Perform Of Utils (A/I RU)	Y	Y			
Act/Inh ESA Use of SPA Utilities (A/I ES)	N				
Act/Inh Commit Criteria Notification (A/I CC)	Y	Y			
Act/Inh Fuel Cell Simulation (A/I FS)	N				
Act/Inh Preview Command (A/I PV)	Y	Y			
Act/Inh System Test (A/I ST)	Y	Y			
Act/Inh Operational Mode (A/I OP)	Y	Y			
Act/Inh PCM Sync Message Routing (A/I SR)	Y	Y			
Act/Inh All Alarms (A/I AA)	Y	Y			
Act/Inh Single Alarm (A/I AL)	Y	Y			
Act/Inh Fire Alarm Notification (A/I FN)	N				
Change GOAL Limits (C GL)	E	Y			
Change CL Limits (C CL)	E	Y			
Change EM Limits (C EL)	E	Y			
Change Responsible Console (C CO)	Y	Y			
Change RCU Number (C RC)	E	Y			
Change Hardware Address (C HA)	Y	Y			
Change Linearization Curve Pointer (C LI)	E	Y			
Change Sample Rate (C RA)	Y	Y			
Change Significant Change Value (C SI)	Y	Y			
Change PCM Bit Sync Bit Error Count (C PS)	Y	Y			
Change PCM Source Select (PCMS)	Y	Y			
Change Physical Port (C PP)	E	Y			
Change In Configuration Indicator (C IC)	E	Y			
Change Digital Filter Constant (C FC)	Y	Y			
Change Reference Designator (REFD)	E	Y			
Change Commit Criteria Console (C CC)	Y	Y			
Change Fuel Cell Aging Constant (C FS)	Y	Y			
Change DECOM to Area Assign. (C DC)	Y	Y			
Change Station Id/Chg Block Seq No. Chk Mode (C SN)	Y	Y			
Change Forward Link (C FL)	Y	Y			
Change Payload Coeff. Scaling Set (UPSC)	Y	Y			
Apply Analog (APPL)	Y	Y			
Set Discrete (SET)	Y	Y			
Issue Digital Pattern (ISSU)	Y	Y			
Stop Repeated MDM Single (STRP)	Y	Y			
Preformatted 48 Bit (P48B)	Y	Y			
Restart React. Sequence At Beginning (RSRS)	E	Y			
Retry Failed Reactive Sequence (RTRS)	E	Y			
Continue Failed Reactive Sequence (CORS)	E	Y			
Switch LDB (SW L)	Y	Y			
Resume LDB Command (RLDB)	Y	Y			
Present Value Of FD (PVO)	Y	Y			
GMEM Read (GPCC LDBA, or GPCC LDBD)	Y				Y
GMEM Write (GPCC LDBA, GPCC LDBD, or GPCC UPLK)	Y				Y
LDB Control (GPCC LDBC)	Y				Y
Explicitly Coded Program (GPCC DDC, RFG, FRT, MAT, BFD, BFM, ACTI)	Y				Y
Dump/Load Onboard Regs. (GPCC DPREG, LDREG)	Y				Y

COMMAND DESCRIPTION	IMPL	CP	SV	SA	UA
SSME Read (GPCC SSME)	Y				Y
SSME Write (GPCC SSME)	Y				Y
TCS Sequence Initiate (TCSS)	Y			Y	
TCS Text Operator (TEXT O/G)	Y	Y			
TCS Stop Operator (STOP <TCS-S)	Y	Y			
TCS Cancel Operator (CANCEL)	Y	Y			
TCS Resume Operator (RESUME)	Y	Y			
Display Electronic Unit (DEUE) Equivalent	Y	Y			
Command BTU Tests (CBTU)	Y	Y			
Set Uplink Activity Indicator (UACT)	Y	Y			
Word-By-Word Correction (WBWC)	Y	Y			
Read Onboard Values (READ)	Y				Y
Command Payload (CPLD)	Y	Y			
Read MEC (RMEC)	Y	Y			
Command MEC (CMEC)	Y	Y			
Two-Stage Buffer Control (TSBF)	Y	Y			
Video Switch Control (VSWI)	N				
Timing and Distribution PBIC Control (TMDS)	N				
Buffer Scan Diagnostic PBIC Control (BSD)	N				
PBIC RAM Read (RAMR)	N				
Initialize Timer (TCGI)	TBD				
Initialize Timer (MTUI)	TBD				
CDT Count At GMT (CDTC)	Y				
MET Count At GMT (METC)	Y				
CDT Hold At CDT (CDTH)	Y				
MET Hold At CDT (METH)	Y				
CDT Hold (CDTH)	Y				
MET Hold (METH)	Y				
CDT Count (CDTC)	Y				
MET Count (METC)	Y				
Set CDT Time (CDTS)	Y				
Set MET Time (METS)	Y				
Reset Pending Commands To Hold Or Count (CDTR)	Y				
Reset Pending Commands To Hold Or Count (METR)	Y				
Switch Timing To External (TCGE)	TBD				
Switch Timing To External (MTUE)	TBD				
Switch Active Time Source (TCGS)	TBD				
Terminate Timer (TCGT)	TBD				
Terminate Timer (MTUT)	TBD				
Allow CDT Control (TCGA)	Y				
Allow MET Control (MTUA)	Y				
Restrict CDT Control (TCGR)	Y				
Restrict MET Control (MTUR)	Y				
GMT Sync (GMTS)	TBD				
Add Linearization Curve (ADDL)	Y			Y	
SPC Buffer Clear (CSPC)	Y	Y			
LDB SRB MDM Lock/Unlock (LOCK/UNLOCK)	Y	Y			
Orbital Computational Facility (OCFI) OCFI (Cont.) (Shuttle Memory Load and Dump) T-20 Minute Compare	Y			Y	Y

COMMAND DESCRIPTION	IMPL	CP	SV	SA	UA
GPC Dump					
GPC Compare					
DEU Dump					
DEU Compare					
Tape Dump Other Than UPF Format					
Tape Dump UPF Format					
List RPL MMU 1					
List RPL MMU 2					
Patch MMU 1					
Patch MMU 2					
Load MMU 1 Without Verification					
Load MMU 2 Without Verification					
Dump MMU 1					
Compare MMU 1					
Dump MMU 2					
Compare MMU 2					
Dump PCM Telemetry Format 64					
Compare PCM Telemetry Format 64					
Dump PCM Telemetry Format 128					
Compare PCM Telemetry Format 128					
Dump PCMOI					
Patch Main Memory via LDB					
Dump BFS Tape					
Compare BFS Tape					
Dump GPC Tape					
Compare GPC Tape					
Dump MMU Tape					
Compare MMU Tape					
Patch Main Memory via UPLK					
Load MMU 1 With Write Verification					
Load MMU 2 With Write Verification					
Block II FDR Dump of EIU x EC x					
Dump DEU Tape					
Compare DEU Tape					
Dump Block II EIU Tape					
Compare Block II EIU Tape					
Block II Dump of EIU x EC x					
Block II Dump of EIU x EC x					
Block II SSME Load EIU x EC x					
T-20 Minute Patch (PT20)	Y			Y	Y
Plotting Measurement Data (PP)	Y			Y	
Hardware Monitor (HWMON)	Y		Y	Y	
Avionics Diagnostics (AVDIAG)	Y				Y
Change SCA Bus Assignment (C BA)	N				
Change Spacelab Coupler (C SL)	N				
Dump Cpu Memory (\$DUMPMEM)	Y			Y	
Display Cpu Memory (\$DPLYMEM)	Y			Y	
Alter Cpu Memory (\$ALTRMEM)	Y			Y	
Dump Disk (\$DUMPDSK)	Y			Y	
Display Disk (\$DPLYDSK)	Y			Y	
Alter Disk (\$ALTRDSK)	Y			Y	
Dump CDBFR (\$DUMPCDB)	N				
Display CDBFR (\$DPLYCDB)	N				
Alter CDBFR (\$ALTRCDB)	N				
Dump Bulk Memory (\$DUMPBLK)	N				

COMMAND DESCRIPTION	IMPL	CP	SV	SA	UA
Display Bulk Memory (\$DPLYBLK)	N				
Alter Bulk Memory (\$ALTRBLK)	N				
Dump Gateway Memory (\$DUMPGW)	Y			Y	
Display Gateway Memory (\$DPLYGW)	Y			Y	
Alter Gateway Memory (\$ALTRGW)	Y			Y	
Dump Halted Gateway Memory (\$UTFEPD)	N				
Display Skeleton (\$DPLYSKE)	N				
Print Load Map (\$MAP)	Y			Y	
Disk Initialization (\$MHDCLR)	N				
Copy/Verify Operating System (\$COPY)	E				
Zero CDBFR (\$ZCDB)	E			Y	
Rebuild Control Logic Sequence (\$CSRBCL)	N				
Load File Patcher (\$PATCHER)	Y	Y			
Application Debug Software (\$ADS)	E			Y	
Application Library List Programs (\$PRTLIB)	E			Y	
Build Tailored Buffer Map (\$BMAP)	E			Y	
Compute (\$COMPUTE)	Y			Y	
Library (\$LIBRARY)	Y			Y	
Remote CPU Memory Dump (\$BTDUMP)	E			Y	
Convert GMT to Hex (\$GMTHEX)	Y			Y	
Command File Processor (\$CMD)	Y			Y	
Dump Library Entry (\$DUMP)	N				
Recall Prompts (\$RECALL)	N				
Global Buffer Map Status Report (\$GBSR)	E			Y	
Print One File (\$PRINT)	N				
List Task Control Block Activity (\$LIST)	E			Y	
Convert Hex to GMT (\$HEXGMT)	Y			Y	
Delete Library Entry (\$DELENT)	E			Y	
Return Library Information (\$INFO)	N				
Create Disk Library (\$BLDLIB)	N				
Dump Bulk Disk (\$DUMPBD)	N				
Dump Bulk Tape (\$DUMPBKT)	E			Y	
Level G Stop Routine (\$GSTOP)	N				
Monitor Gateway Memory (\$MONGW)	Y			Y	
Search CDBFR (\$SRCHCDB)	N				
Search Gateway Memory (\$SRCHGW)	Y			Y	
Search CPU Memory (\$SRCHMEM)	Y			Y	
Monitor CPU Memory (\$MONMEM)	Y			Y	
Monitor CDBFR (\$MONCDB)	N				
Patch Data Sets (\$PATCH)	E			Y	
Merge Library Entry (\$MRGENT)	E			Y	
POCC Command Preview (\$PREVU)	Y		Y	Y	
Time Status (\$TIME)	N				
Message Broadcast (\$MSGB)	N				
Display/Alter On-Line Data Bank (\$OLDB)	Y			Y	
Display DG Page/PFP Presentation (\$DGPG)	N				
GOAL Procedure Status (\$GOAL)	E			Y	
Bulk Disk Clear/Copy/Verify (\$BULK)	N				
Print Bad Sector table (\$PBST)	N				
Copy GOAL Disk File (CGDF)	E	Y			
TCID Information Formatted (TCID)	Y			Y	
GOAL IC Operator Dump (\$GLDUMP)	E			Y	
GOAL IC Operator Dump At SPA (\$GLSPA)	N				

COMMAND DESCRIPTION	IMPL	CP	SV	SA	UA
Arithmetic Expression Evaluator (\$CALC)	N				
Transient Memory Dump Formatter (\$STTWA)	N				
Text Editor (\$T)	Y			Y	
Date (\$DATE)	Y			Y	
Execute Command File (\$CMD)	N				
Firing Room Configuration Verify (\$VERIFY)	N				
Snap Registers (\$SNAP)	N				
Status On-Line Data Bank (\$STOLDB)	Y				
Dump TR Library Entry (\$TRDUMP)	N				
Skeleton Build (\$SKLBLD)	N				
Monitor Locations in Memory (\$MON)	Y			Y	
Alter Memory In OC Task (\$ALTROC)	N				
Avionics Diagnostics Loader (AVLOAD)	Y			Y	
Bulk Disk Installation (\$BDINST)	N				
Bulk Disk Preload (\$BDPRELD)	N				
Build Control Logic File (\$BLDCL)	N				
LDB BTU FD Status (\$BTU)	N				
Change IC And Physical Port And RCU (\$C)	N				
Computer Assisted Instruction (\$CAI)	N				
Write Meas. Values & FEP Exceptions (\$CDBFRW)	Y			Y	
Command File Executor - OC Task (\$CMDOC)	N				
Buffer Stress Test Monitor (\$CSD)	E			Y	
Configuration Update Allow/Inhibit (\$CSUBUP)	N				
DIT Control Program (\$DITCP)	N				
DIT Monitor (\$DITMON)	N				
ORT 50KB Test Item 1 (\$DP150K)	E			Y	
ORT Bulk Memory Test Item 1 (\$DP1BM)	E			Y	
ORT CDBFR Interface Test Item 1 (\$DP1CDB)	E			Y	
ORT DG Test Item 1 (\$DP1DG)	E			Y	
ORT MHD Test Item 1 (\$DP1MHD)	E			Y	
ORT MMD Test Item 1 (\$DP1MMD)	E			Y	
ORT PFP Test Item 1 (\$DP1PFP)	E			Y	
ORT PIT Test Item 1 (\$DP1PIT)	E			Y	
ORT P/P Test Item 1 (\$DP1PP)	E			Y	
ORT CPU Presence Test Item 2 (\$DP2CDB)	E			Y	
ORT BSD PBIC Item 3 (\$DP3BSD)	E			Y	
ORT FIFO Address Matrix Test Item 3 (\$DP3FAM)	E			Y	
ORT MTU Test Item 3 (\$DP3MTU)	E			Y	
ORT MTU Logging Test Item 3 (\$DP3MTUL)	E			Y	
ORT PDR/Spa Logging Test Item 3 (\$DP3PDR)	E			Y	
ORT RTIF Test Item 3 (\$DP3RTI)	E			Y	
ORT TCG Test Item 3 (\$DP3TCG)	E			Y	
ORT TCG Logging Test Item 3 (\$DP3TCGL)	E			Y	
ORT TMDS Test Item 3 (\$DP3TMD)	E			Y	
ORT VDA Test Item 3 (\$DP3VDA)	E			Y	
ORT Bulk Disk Test Item 4 (\$DP4BD)	E			Y	
ORT Bulk Tape Test Item 4 (\$DP4BT)	E			Y	
ORT CRT Test Item 4 (\$DP4CRT)	E			Y	
ORT Local Driver Item 4 (\$DP4DRC)	E			Y	
ORT Flt.Point Option Plane Test Item 4 (\$DP4FLT)	E			Y	
ORT Line Printer Test Item 4 (\$DP4LPT)	E			Y	
ORT Standard Tape Test Item 4 (\$DP4STT)	E			Y	
ORT Console Subsystem Test Item 5 (\$DP5CON)	E			Y	

COMMAND DESCRIPTION	IMPL	CP	SV	SA	UA
ORT P/P Subsystem Test Item 5 (\$DP5PP)	E			Y	
ORT PDR/Spa Subsystem Test Item 5 (\$DP5SPA)	E			Y	
ORT BSD PBIC Test (\$DPBSD)	E			Y	
FIFO Bulk Disk Test (\$DPFBDT)	E			Y	
ORT Master Driver (\$DPLORT)	E			Y	
Display Memory (As Application Pgm) (\$DPLYOC)	N				
ORT Safing Test Monitor (\$DPSAFE)	N				
ORT Test Tape Routine (\$DPTAPE)	N				
Dump Memory (As Application Pgm) (\$DUMPOC)	N				
Goal Procedure Status (\$GPST)	N				
Goal System Status (\$GSYS)	N				
Inhibit (Level G Version) (\$I)	N				
CPRO LDB Analog Meas. Status (\$L1)	D				
CPRO LDB Analog Stimulus Status (\$L2)	D				
CPRO LDB Discrete Meas. Status (\$L3)	D				
CPRO LDB/UPLK Discrete Stimulus Status (\$L4)	D				
CPRO LDB Digital Pattern Meas. Status (\$L5)	D				
CPRO LDB/UPLK Digital Pattern Stimulus Status (\$L6)	D				
LDT Status (\$LS)	D				
50 Kb Test S/W (\$MCTPDM)	N				
OC Time Crit. Patcher (\$OCFTCP)	N				
OCF Tester Dump (\$OCFTST)	N				
OCF Interface (OC Version) (\$OCU)	N				
Change Analog Trace (\$PPCHTR)	Y			Y	
Print & Plot Compressed Data (\$PPMLOT)	N				
Remote Plot Request (\$PPRDR)	Y			Y	
Select Maximum Channel Size (\$PPSIZE)	Y			Y	
Process Plot Playback Data (\$PSP)	E			Y	
Pseudo/System FD Status (\$PSS)	D				
PVO For Time Homogeneous Data Set (\$PV)	D				
LDB/UPLK Request ID Status (\$R1)	D				
Reference Designator Change (\$REF)	D				
CPRO Read Onboard Values (\$ROV)	D				
CPRO Analog Meas. Status (\$S1)	D				
CPRO Analog Stimulus Status (\$S2)	D				
CPRO Discrete Meas. Status (\$S3)	D				
CPRO Dbl Precision Analog Meas. Status (\$S35)	D				
CPRO Multiword Dig. Pattern Meas. Status (\$S37)	D				
CPRO GPC Floating Point Analog Meas. Status (\$S38)	D				
CPRO Data Set FD Status (\$S39)	D				
CPRO Discrete Stimulus Status (\$S4)	D				
CPRO Digital Pattern Meas. Status (\$S5)	D				
CPRO Digital Pattern Stimulus Status (\$S6)	D				
SPA Retrieval Utility (\$SPAUTL)	N				
BFL Retrieval (\$SPBLOK)	Y			SDC	
File Card-Images To Cartridge Disk (\$SPCARD)	N				
Console Activity Trace (\$SPCAT)	Y			SDC	
CITE POCC Interface Retrieval (\$SPCPIR)	Y			SDC	
CTOC Retrieval (\$SPCTOC)	Y			SDC	
Goal Language Trace (\$SPGLT)	Y			SDC	
LDB/UPLK Command Retrieval (\$SPLDUP)	Y			SDC	
Measurement & Command Retrieval (\$SPMACR)	Y			SDC	

COMMAND DESCRIPTION	IMPL	CP	SV	SA	UA
Compressed Data Point Retrieval (\$SPMCDP)	N				
Pwr Metering Compressed Data Retrieval (\$SPMCDR)	N				
Tape Compression (\$SPMCPT)	N				
Compressed Data Summary Retrieval (\$SPMDSR)	N				
Spooler (Print Data) Control (\$SPOOL)	E			Y	
Operator Communications Retrieval (\$SPOPCR)	Y			SDC	
SPA Operating System Compare Utility (\$SPOSCM)	E			Y	
Plot Spa Data (\$SPP)	E			Y	
Pseudo FD Descriptor Restore (\$SPPSDR)	E			Y	
Log Tape Raw Dump (\$SPRAW)	Y			SDC	
Recovery Dump Retrieval (\$SPRCVE)	Y			SDC	
Request Data Reduction (\$SPRDR)	Y			Y	
Single Address Retrieval (\$SPSAR)	Y			SDC	
Shuttle Memory Retrieval (\$SPSMR)	Y			SDC	
Range Safety Retrieval (\$SPRCR)	Y			Y	
CDBFR Snapshot Retrieval (\$SPSNPR)	N				
Tape Status/Reset (\$SPSTST)	N				
Tape Reassignment (\$SPTASW)	N				
PDR Tape Copy (\$SPTCOP)	N				
Tape Copy Verify (\$SPTCPV)	E			Y	
TCID Save/Restore (\$SPTCSR)	N				
TCID Save/Verify (\$SPTCSV)	N				
Task Status Program (\$STAT)	Y		Y		Y
Status Goal Tables (\$STGT)	N				
Dump OC TWA Partition (\$STTWAOC)	N				
CPRO Msg Output For Invalid FD Type (\$T3)	D				
CPRO TMDS Discrete Stimulus Status (\$T4)	D				
CPRO Msg Output For Invalid FD's (\$T5)	D				
CPRO TMDS Dig. Pattern Status (\$T6)	D				
Dump Halted FEP (\$UTFEPD)	N				
Video Switch Utility (\$UTVSWI)	N				
CPRO Video Switch Set/Reset (\$VSO)	N				
CPRO Status Video Switch (\$VSS)	N				
CPRO Control Video Switch (\$VSW)	N				
Switch GPC/DIO modes (SWLDB)	New				Y

Appendix D. — ACRONYMS

- A -

ACA	ADAS Command Application
ADAS	Advanced Data Acquisition System
AERO	Automated Electrical Retest Operations
ALS	Automated Logging System
AMRS	Automated Material Request System
ANSI	American National Standards Institute
AOS	Analog Overflow Signed
API	Application Program Interface
APU	Auxiliary Power Unit
ASM	Analog Serial Measurement
ATM	Asynchronous Transfer Mode
AWPS	Automated WAD Processing System

- B -

B/U	Backup
BCD	Binary Coded Decimal
BFL	Block Funnel Logged
BIN	Business and Information Network
BTU	Bus Terminal Unit

- C -

C&T	Communications and Tracking
CADS	Command and Data Simulator
CCC	Complex Control Center
CCMS	Checkout, Control, and Monitor System
CCP	Command and Control Processor
CCS	Complex Control Set
CDBFR	Common Data Buffer
CDT	Countdown Time
CEA	Common Equipment Area
CEU	Calibrated Engineering Units
CI	Configuration Item
CIE	Communications Interface Equipment
CITE	Cargo Integrated Test Equipment (Set)
CLCS	Checkout and Launch Control System
CM	Configuration Management
COLA	Collision Avoidance
COTS	Commercial Off the Shelf
CPDS	Computer Program Development Specifications
CPU	Central Processor Unit
CRMP	Command and Real-Time Monitor Position
CRT	Cathode Ray Tube
CS	Consolidated Systems
CSC	Computer Software Component
CSCI	Computer Software Configuration Item
CWLIS	Catenary Wire Lightning Instrumentation System

- D -

DAP	Data analysis and Presentation
D/L	Downlink
DBSAFE	Data Bank Shuttle Automated Function Executive
DCN	Display and Control Network
DD	Data Dictionary
DDP	Data Distribution Processor
DFRC	Dryden Flight Research Center (Set)
DIO	Direct Input/Output

DLES	DPS LCC Expert System
DPS	Data Processing System
DSR	Display Synchronous Rate
- E -	
EDAMS	Engineering Data Access Management System
EDL	Engineering Development Laboratory
EIU	Engine Interface Unit
EU	Engineering Units
- F -	
FCAP	Facility Condition Assessment Program
FD	Function Designator
FDDI	Fiber Distributed Data Interface
FDID	Function Designator ID
FEP	Front End Processor
FOTE	Fiber Optic Terminal Equipment
FTP	File Transfer Protocol
FZ	Flow Zone
- G -	
GCP	Gateway Control Processor
GDB	Ground Data Bus
GMS	Ground Measurement System
GMT	Greenwich Mean Time
GOAL	Ground Operations Aerospace Language
GPC	General Purpose Computer
GSE	Ground Support Equipment
GUI	Graphical User Interface
G/W	Gateway
- H -	
HAZGAS	Hazardous Gas
HCI	Human Computer Interface
HGDS	Hazardous Gas Detection System
HIM	Hardware Interface Module
HMF	Hypergol Maintenance Facility (Set)
HOSC	Huntsville Operations Support Center
HUMS	Hydrogen Umbilical Mass Spectrometer
HWCI	Hardware Configuration Item
- I -	
IAPU	Improved Auxiliary Power Unit
IDE	Integrated Development Environment
IEEE	Institute of Electrical and Electronic Engineers
I/O	Input/Output
IP	Internet Protocol
IPR	Interim Problem Report
IRIG-B	Inter-Range Instrumentation Group
ISO	International Standards Organization
IVT	Interface Verification Testing
IWCS	Integrated Work Control System
- J -	
JSC	Johnson Space Center
- K -	
KATE	Knowledge-Based Autonomous Test Engineer
KATS	Kennedy Avionics Test Set
Kb	Kilo-bit
Kbs	Kilo-bits per second
KB	Kilo-Byte
KBS	Kilo-Bytes Second

KEDS Kennedy Electric Drawing System
KSC Kennedy Space Center
KSDN Kennedy Switched Data Network

- L -

LACD Local Acquisition, Command, and Display Subsystem
LAN Local Area Network
LATMOS Lightning and Transients Monitoring System
LDBM Launch Data Bus Monitor
LCC Launch Control Center
LCC Launch Commit Criteria
LDB Launch Data Bus
LO₂ Liquid Oxygen
LOC Lines of Code
LON LPS Operational Network
LH₂ Liquid Hydrogen
LPS Launch Processing System
LRU Line Replaceable Unit
LS Launch Sequence
LSDN LPS Software Development Network
LIVIS Lightning Induced Voltage Instrumentation System

- M -

Mb Megabit
Mbs Megabits per second
MB Megabyte
MBs Megabytes Second
MCP Model Control Procedures
MDM Multiplexer/Demultiplexer
ME Main Engine
MER Mission Evaluation Room
MET Mission Elapsed Time
MFR Multi-function Room
MFSC Marshall Space Flight Center
MILA Merritt Island Launch Area
MM Mass Memory
MMU Mass Memory Unit
MOIR Mission Operations Integration Room
MPT Mini-Peripheral Test (Set)
MSec Millisecond
MTBF Mean Time Between Failure
MTTR Mean Time To Repair
MTU Mission Timing Unit

- N -

NASA National Aeronautics and Space Administration
NFS Network File System
NSP Network Signal Processor

- O -

O&M Operations and Maintenance
OCF Orbiter Computational Facilities
OCR Operations Control Room
OFI Operational Flight Instrumentation
OIS Operational Intercom System, also OI Standby (FEP)
OLDB On Line Data Base
OLSA Orbiter LPS Signal Adapter
OMI Operations and Maintenance Instruction
OMRSD Operations and Maintenance Requirements and Specification Documentation
OMS Orbital Maneuvering System
OPF Orbiter Processing Facility

ORT	Operational Readiness Test
OTV	Operational Television
OV	Orbiter Vehicle
- P -	
PAMS	Portable Aft Mass Spectrometer
PCC	Processing Control Center
PCL	Prerequisite Control Logic
PCM	Pulse Coded Modulation
PCMMU	Pulse Coded Modulation Master Unit
pF	Pico-Farad
PFP	Programmable Function Panel
PLC	Programmable Logic Controller
PMS	Permanent Measurements System
POCC	Payload Operations Control Center
POST	Power On Self Test
ppm	Parts Per Million
PRACA	Problem Reporting and Corrective Action
PSCNI	Program Support Communications Network Internet

- Q -

- R -

RADS	Remote Acquisition and Display Subsystem
RAID	Redundant Array of Inexpensive Disks
RCS	Reaction Control System
RCVS	Remote Controlled Video Switch??
RNET	Reconfiguration Network
RON	Restricted Operational Network
RSYS	Responsible System
RTCN	Real-Time Critical Network
RTPS	Real-Time Processing System
RTU	Remote Terminal Units

- S -

SACS	Systems Software Avionics Command Support
SAIL	Shuttle Avionics Integration Lab (Set)
SBC	Single Board Computer
SCA	Sequence Control Assembly
SCAN	Shuttle Configuration Analysis Network
SCID	System Configuration Identifier
SCSI	Small Computer System Interface
SCT	System Configuration Table
SDC	Shuttle Data Center
SDE	Satellite Development Environment
SDS	Shuttle Data Stream
SDT	Shuttle Data Tape
SECAS	Shuttle Engineering Computer Application System
SGOS	Shuttle Ground Operations Simulator
SIM	Simulation System
SIMS	Still Image Management System
SL	Space Lab
SLOC	Source Lines of Code
SL-GMS	Sherrill-Lubinski-Graphical Modeling System
SLP	SSME Load Program
SLS	System Level Specification
SLWT	Super Light Weight Tank
SODN	Shuttle Operations Data Network
SONET	Synchronous Optical Network
SPDMS	Shuttle Processing Data Management System
SPF	Software Production Facility

SRB	Solid Rocket Booster
SSC	Stennis Space Center
SSME	Space Shuttle Main Engine
SSPF	Space Station Processing Facility
SSR	System Synchronous Rate
STM	Synchronous Transfer Mode
- T -	
TAB	TACAN Bearing (SDT Type)
TACAN	Tactical Air Navigation
TBD	To Be Defined
TCID	Test Control Identifier
TCMS	Test, Control and Monitor System
TCP	Transmission Control Protocol
TCS	Test Control Supervisor
TCS-1	Test Control Supervisor - Single Command
TCS-S	Test Control Supervisor - Sequence
TDM	Time Division Multiplexing
TEI	Test End Item
THDS	Time Homogenous Data Set
- U -	
UOPS	Utility Outage Processing System
USCA	Universal Signal Conditioning Amplifier
UTC	Universal Time Coordinated
- V -	
V&DA	Video and Data Assembly
VAB	Vehicle Assembly Building
VHMS	Vehicle Health Management System
VP	Vehicle Processing (Set)
VPF	Vertical Processing Facility
VSI	Video Simulation Interface
VTP	VME Telemetry Processor
- W -	
WAN	Wide Area Network
W/S	Workstation
- X - Z -	